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RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

EDITOR

Howard P. Doub, M.D.
Detroit, Michigan

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Radiological Diagnosis of Anomalous Pulmonary Venous Connection: A Tomographic Study[1]

F. DALITH, M.D., and H. NEUFELD, M.D.

ANOMALOUS PULMONARY venous connection is a congenital malformation in which one, several, or all of the pulmonary veins empty into the right atrium or one of its tributaries. We adhere to the strictly anatomical designation, anomalous *connection* (12), in preference to anomalous *drainage* or *return*, which terms are not always synonymous. Likewise, *transposition*, which commonly refers to the malrotation, of the larger arteries, and *transplantation*, which designates a surgical procedure, seem to be better avoided in this context. The route by which the pulmonary venous blood reaches the right atrium is of far less clinical significance than the amount of blood thereby recirculated (13). It is essential to distinguish between the two main forms of the anomaly, partial and total.

In partial anomalous pulmonary venous connection, one or several, but not all the pulmonary veins drain into the right atrium or a systemic vein (21, 35). The hemodynamic situation is identical with that in uncomplicated atrial septal defect. Only when the recirculation of already oxygenated blood exceeds 50 per cent of the total, do clinical features make their appearance, and that only in adult life. Seventy-five per cent of patients are said (2) to reach maturity. The excessive pulmonary flow may manifest itself in accentuation of the pulmonary second sound and a systolic murmur maximal there, together with electrocardiographic evidence of an increased burden on the right ventricle. It is evident that the diagnosis, which requires location of the left-to-right shunt, may be very difficult and depend entirely on special investigations.

In total anomalous pulmonary venous connection, on the other hand, the right atrium receives *all* the pulmonary venous blood, in addition to the systemic return. The left heart, and through it the systemic circulation, receives only this admixed blood through a persistent foramen ovale, which is essential for life. Clinically, cases fall into one of two groups depending, it would seem, on the size of the foramen ovale (6). Where this defect is large, the pulmonary blood flow will not be so excessive; however, the amount of admixed blood reaching the left heart will be considerable and will result in cyanosis, and usually in death within the first year. If the foramen ovale is small, the pulmonary recirculation will be greater, but the blood reaching the systemic circulation, though minimal, will be better oxygenated. Cyanosis is not seen in this group even in the terminal phase. In addition to the usual symptoms and signs of increased burden on the right ventricle and poor

[1] From the Departments of Radiology and Cardiology, Government Hospital, Tel-Hashomer, Israel. Submitted for publication in September 1958,

systemic output, the electrocardiogram indicates extreme right heart hypertrophy and may show a characteristic Q wave in the right precordial leads. Failure and death usually ensue before middle age.

The diagnosis of anomalous pulmonary venous connection is of no small practical importance for it is one of the anomalies responsible for left-to-right shunt that are amenable to surgical treatment. In addition, the diagnosis will forestall incidental detection or unplanned ligation of anomalous veins during cardiac or lung surgery. Awareness of the presence of the abnormality warns against detrimental resection in the contralateral normally drained lung.

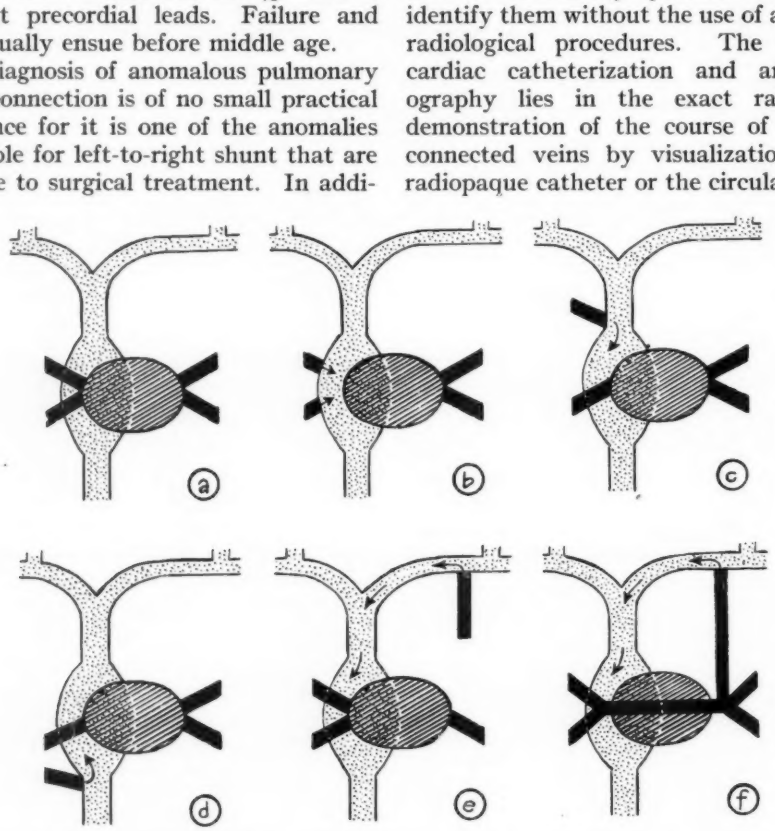


Fig. 1. Diagrammatic sketch of anatomical forms of anomalous pulmonary venous connection, as observed in our series. (a) Normal pulmonary venous connection. (b) Partial anomalous pulmonary venous connection, right, to right atrium. (c) Partial anomalous pulmonary venous connection, right, to superior vena cava or at upper atriocaval junction. (d) Partial anomalous pulmonary venous connection, right, to inferior vena cava or at lower atriocaval junction. (e) Partial anomalous pulmonary venous connection, left, to left innominate vein *via* partially persistent left superior vena cava. (f) Total anomalous pulmonary venous connection, to left innominate vein *via* partially persistent left superior vena cava.

The features of certain types of anomalous pulmonary venous connection in conventional radiological examination are strikingly characteristic. Other types, however, may be present without revealing evidence in the routine roentgenogram, and it is not always possible to detect or identify them without the use of additional radiological procedures. The value of cardiac catheterization and angiocardiography lies in the exact radiological demonstration of the course of the malconnected veins by visualization of the radiopaque catheter or the circulating contrast medium. These methods, however, are complex, time-consuming, and not without inherent risk to the patient. Tomography, on the other hand, is an innocuous technic and free from hazards. Relatively few reports of its use in the diagnosis of anomalous pulmonary venous connection appear in the literature, and then only with regard to one type of the partial form: a right pulmonary vein connecting with the inferior vena cava. The

present authors have examined tomographically several other types of partial anomalous pulmonary venous connection as well as one case of the total form.

It is the purpose of this article to review the radiological appearance of anomalous pulmonary venous connection as described in the literature, to report on new radiographic appearances revealed by tomographic investigation of 9 patients, and to emphasize the value of tomography in (*a*) detection of the anomaly, (*b*) visualization of its detailed morphology, and (*c*) demonstration of associated bronchopulmovascular anomalies.

REVIEW OF LITERATURE

1. Normal Pulmonary Venous Connection

The anatomy of the normally connected pulmonary veins (1, 18), their identification in conventional radiography (27, 29, 34, 37, 40), and their radiological appearances in tomography (22) have been described in detail elsewhere.

2. Anomalous Pulmonary Venous Connection

No adequate up-to-date estimate of the incidence of anomalous pulmonary venous connection is available. Anomalous connection to the right atrium and to every one of its venous tributaries has been reported (2, 23, 35).

In the *total* form, the most common site of anomalous connection appears to be to the left innominate vein *via* a partially persistent left superior vena cava. The coronary sinus, right atrium, and right superior vena cava are other sites involved, in that order of frequency. There are reports, too, of insertion into the portal vein, ductus venosus, and inferior vena cava (17, 25, 26).

Appearances in Conventional Radiography: A number of characteristic radiological appearances of certain types of anomalous pulmonary venous connections in the conventional thoracic roentgenogram are described. The features relate to the region, course, and site of entry of the anomalously connected vein, secondary changes in the heart and the great vessels due to the left-to-right shunt, and frequently associated congenital anomalies of heart, pulmonary artery, bronchial tree, and lung lobes.

(*A*) *Changes in Lung Fields and Hilar Region.* (1) *Abnormal Vascular Pattern.* (*a*) *Anomalous Coursing Pulmonary Vein:* Veins of the right lung drain into the right atrium. The presence of an anomalous venous connection of this type is not usually suspected from the conventional roentgenogram, since the veins pursue a course differing only slightly from the normal (Fig. 2). The general appearance is similar to that of uncomplicated atrial septal defect. Several authors (4, 38) report no evidence of this anomaly. Others (14, 31, 33), however, have found unusual vascular shadows or wide bands of increased density in the medial basal area of the right lung field adjacent to the right heart border.

Veins of the right lung drain into the superior vena cava or at the upper atriocaval junction. In the plain roentgenogram there is to be seen an abnormal vascular shadow variously described (21, 31, 36). There is, in addition, an appearance of a branching effect in the lung fields without demonstrable disturbance of the surrounding lung (20, 35). The vascular shadow courses in a craniocaudal direction parallel to the right cardiac border at a short distance from or within it (6, 30). It increases in width from above downward, becomes a single trunk near the diaphragm, descends toward the right cardiohepatic region, and disappears from view in the shadow of the hemidiaphragm or in the right cardiophrenic angle (4, 6, 33). Pulsations are not discernible. The vascular nature of the shadow may be proved by decrease of its diameter (38) and density (20) during Valsalva's test.

(*b*) *Changes of Pulmonary Artery Markings:* The vascularity of the lung fields depends on the amount of left-to-right shunt. Increased vascularization of the

lung fields, especially in that part of the lung with which veins are abnormally connected (31), together with the large size of the pulmonary artery, is likely to occur in partial anomalous pulmonary venous connection and is always observed when the anomaly is total. A small pulmonary artery on the side of the anomalous connection is attributed to hypoplasia of this vessel (36) or to diminished function of the lung on the involved side (10). The roentgenograms of all patients (6) have shown evidence of vascular engorgement such as is seen in the case of recirculation; for the present, therefore, increase in the peripheral pulmonary arterial markings should be regarded as an essential part of the radiological diagnosis. In all of 30 patients (17) who survived three or more months, pulmonary vascularity was markedly increased.

In partial anomalous pulmonary venous connection, in some cases, the enlarged main pulmonary arteries pulsate vigorously (4), but this is not always so (35). In total anomalous pulmonary venous connection, the pulmonary trunk and its branches always show considerable exaggeration of pulsations (6).

(2) *Changes of Pulmonary Volume:* Decreased pulmonary volume on the involved side is described as a part of the radiological syndrome in some cases of partial anomalous pulmonary venous connection on the right side. The smaller volume is attributed to diminished function and smaller blood flow of the anomalously drained lung (17) or to hypogenesis of the lung (21).

(*B*) *Changes of Upper Mediastinum.* (1) *Bilateral Enlargement of Upper Mediastinal Shadow:* A saccular bulging of both sides of the upper mediastinum results from dilatation of a partial persistent superior vena cava on the left ("left vertical vein" or "left connecting vein") and of the superior vena cava on the right side. The rounded upper mediastinal shadow, together with the enlarged heart, has been variously designated as a figure-of-eight, dumb-bell, cottage-loaf, or mediastinal-moustache profile (16, 35, 36, 39). The shadow in the upper mediastinum produced by the vessels may be almost as wide as the shadow in the lower mediastinum produced by the heart. The mediastinal shadow may show expansile pulsation (39).

Bilateral bulging of the upper mediastinum has come to be accepted as the typical radiological sign for that type of total anomalous pulmonary venous connection in which the pulmonary veins of the right side join a partially persistent left superior vena cava, which also receives all the venous return from the left lung and drains into the left innominate vein. The right pulmonary veins and the partially persistent left superior vena cava are connected by a transverse venous sinus, which passes behind the upper portion of the left atrium without communicating with it. It should be kept clearly in mind, however, that bilateral bulging of the upper mediastinum is seen in only about half of those reported cases in which anomalous pulmonary vessels empty into a persistent left superior vena cava (17). In addition, bilateral enlargement of the upper mediastinal shadow has also been observed in patients with the partial form (19, 33).

(2) *Unilateral Enlargement of Upper Mediastinal Shadow.* (*a*) *Enlargement to Right:* A convex bulging of the right upper mediastinal shadow has been described in patients with partial anomalous connection of the right lung to the superior vena cava (31).

(*b*) *Enlargement to Left:* In cases of partial anomalous connection *via* a persistent partial left superior vena cava, this dilated vessel causes enlargement of the superior mediastinal shadow to the left. In 2 cases, confirmed by angiography (31), where the flow was downward *via* the coronary sinus to the right atrium, this enlargement was straight-bordered. The enlargement was more prominent, and even convex-bordered, in patients in whom the left superior vena

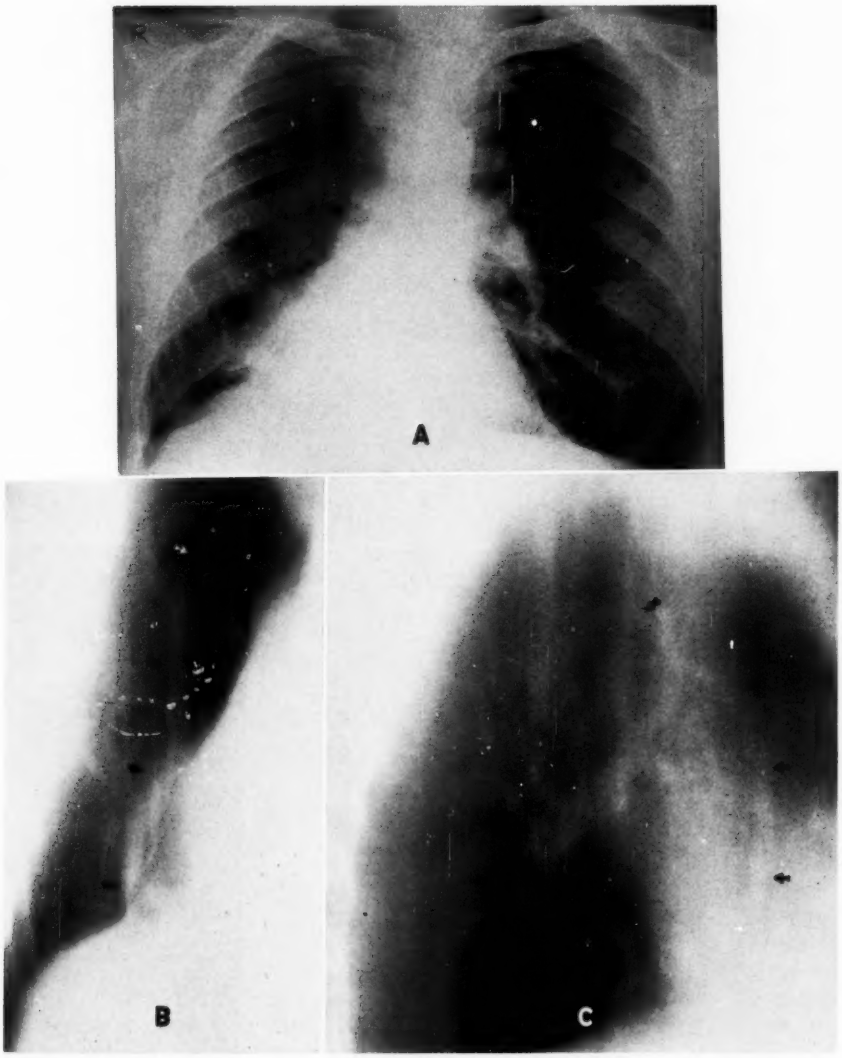


Fig. 2. Case I. Partial anomalous connection of right upper lobe veins to inferior vena cava.
A. Postero-anterior roentgenogram showing deficient volume of right lung indicated by narrowing of intercostal spaces, decreased pulmonary vascularity, displacement of heart to right, emphysema, inconspicuous right main pulmonary artery. No abnormally coursing vascular shadow detectable in the lung fields.
B. Anteroposterior tomogram, right, 14 cm., revealing anomalously connected pulmonary vein extending from apex to base (arrows).
C. Latero-oblique tomogram, right, 8 cm., showing the anomalously connected vein (arrows) receiving small anterior and posterior tributaries in its upper third only. The lower two-thirds, of uniform width, courses through anterior third of chest. Small elongated "pulmonary oval," in relatively low situation. Flattening of posterior part of diaphragm.

cava connected above to the left innominate vein, as proved by catheterization and angiocardiography (33).

(*C*) *Changes of Heart and Great Vessels.* (1) *Position:* In cases of partial anomalous connection of the right lung veins, a variable degree of shift of the heart shadow into the right hemithorax or a bulge of the right cardiac border and inconspicuousness of the left side (31) are observed.

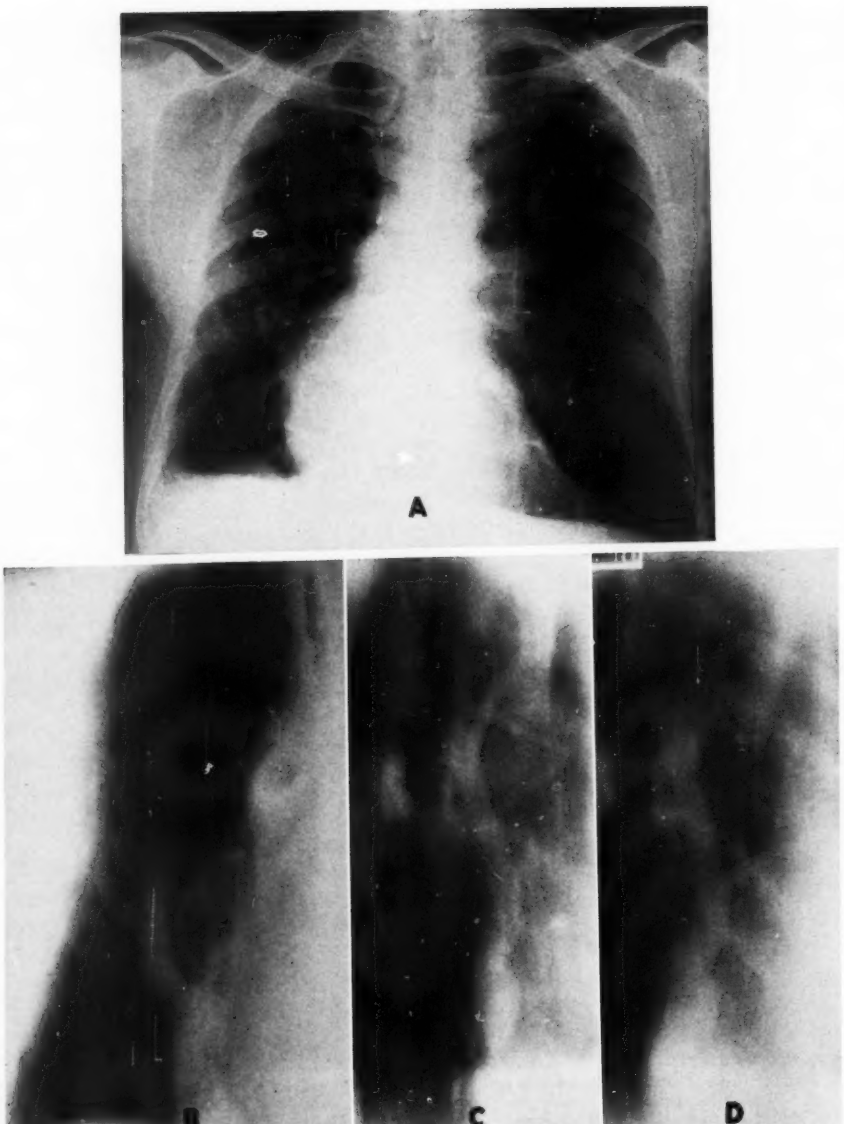


Fig. 3. Case II. Partial anomalous connection of right lung veins to inferior vena cava.

A. Conventional postero-anterior roentgenogram: Small right hemithorax and displacement of heart to right. Abnormal vascular pattern on right side: convex bulge at site of right main pulmonary artery, absence of normal pulmonary artery ramification, and branching vascular shadow parallel to, and partly superimposed on right border of heart shadow.

B. Anteroposterior tomogram, right, 10 cm.: Fuller demonstration of shape and course of anomalously connected vein, beginning at the apex, broadening from above downward, receiving tributaries on its medial and lateral aspects and disappearing in cardiophrenic angle. No normal veins detected on this side. In the right tracheobronchial angle a dense opacity, its lateral border convex, represents hypoplastic right main pulmonary artery.

C and D. Latero-oblique tomograms, right, 8 and 7 cm., respectively: Paracardial layers, showing shape and full extent of the vein, which drains all regions of the lung. Absence of any normal vein.

TABLE I: ANOMALOUS PULMONARY VENOUS CONNECTION: CLINICAL AND ELECTROCARDIOGRAPHIC MANIFESTATIONS

Case No.	Clinical Diagnosis: Anomalous Pulmonary Venous Connection	Clinical Diagnosis: Associated Cardiac Vascular Anomalies	Sex and Age	Physical Development	Dyspnea	Cyanosis	Clubbing of Fingers	Cardiac Murmur	Pulmonary Second Sound	Electrocardiographic Findings	Reasons for Examination
I	Partial	....	M57	N	−	−	−	−	−	N	Cough
II	Partial	....	M56	N	−	−	−	−	−	N	Precordial pain
III	Partial	....	F21	N	−	−	−	−	−	N	Hemoptysis
IV	Partial	....	F14	N	−	−	−	−	−	N	Routine school examination
V	Partial	PDA	F11	U	−	−	−	−	−	Early LHH	Machinery murmur
VI	Partial	Complete transposition	M8	N	+	+	+	Systolic	−	RHH	Symptoms of main anomaly
VII	Partial	ASD	F54	N	+	−	−	−	+	RBBB	Palpitation, dyspnea
VIII	Partial bilateral	....	M20	N	−	−	−	Systolic	+	RHH	For military service
IX	Total	....	F22	U	+	+	−	Diastolic	+	Marked RHH	Palpitation, dyspnea

ASD. Atrial septal defect. LHH. Left heart hypertrophy. N. Normal. PDA. Patent ductus arteriosus. RBBB. Right bundle-branch block. RHH. Right heart hypertrophy. U. Underdeveloped.

The degree of shift of the heart to the right, due to hypogenesis of the right lung, is sometimes so prominent that dextrocardia is suspected.

(2) *Size and Shape:* Bulging of the right cardiac border (dilatation of the right atrium and hypertrophy of the right ventricle) and enlargement of the pulmonary artery segment are almost always present in partial anomalous pulmonary venous connection (13, 33). The aorta is usually small, because of the diminished systemic blood flow (4). A box-like appearance of the heart shadow (17) or a globular enlargement (31) may be seen.

(*D*) *Changes of Other Thoracic Structures:* The following associated congenital anomalies of structure and distribution on the side of the venous malconnection have been observed in general, postmortem or surgically or by angiocardiography and bronchography: hypoplasia and abnormal ramification (36), accessory pulmonary arteries from the aorta (8, 21); bronchial distribution on the right side which is a mirror-image of the left, cystic diverticula, blind pouches, bronchiectasis (6, 8, 11, 21); hypoplasia and agenesis of a pulmonary lobe (11, 21); reduplication of the posterior part of the diaphragm (11).

Radiological Appearances in Tomography: Relatively few publications deal, to our knowledge, with tomography in the diagnosis of anomalous pulmonary venous connection. Only in cases of malconnection of the right pulmonary veins to the inferior vena cava is the use of this procedure reported in the literature (6, 13, 21, 30, 31, 35). Different authors stress the value of tomography in demonstrating more clearly the abnormal vascular shadow and its abnormal communication, and in confirming a suspicion aroused by the conventional roentgenogram. One (36) points out the possibilities of tomography for visualization of additional structural details: the decrease in size of the hilar shadow ("pulmonary oval") due to the absence of its venous component and to hypoplasia of the right pulmonary artery, and the absence of the horizontal coursing of the right lower lobe veins.

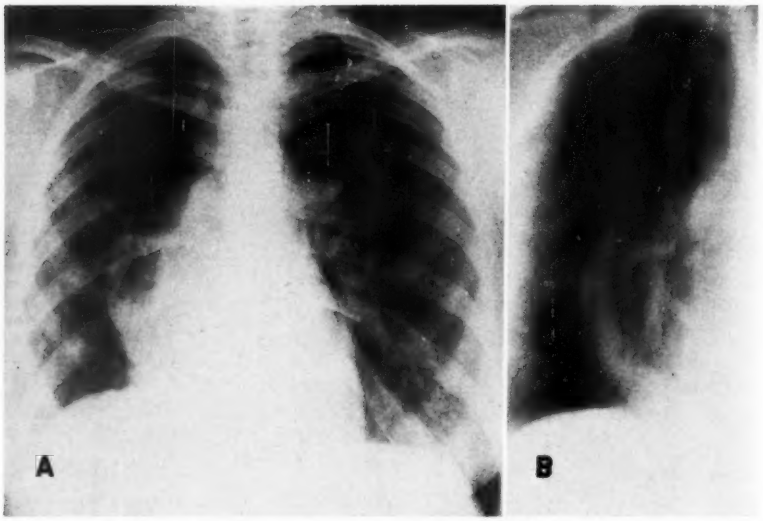


Fig. 4. Case IV. Partial anomalous connection of most of right lung veins to inferior vena cava.

A. Conventional postero-anterior roentgenogram: Decreased size of right hemithorax and slight displacement of heart and mediastinum to right. Inconspicuous right main pulmonary artery shadow. Curved vascular shadow paralllel to and partly superimposed on right border of heart shadow. Slight increase of pulmonary vascularity on left.

B. Anteroposterior tomogram, right, 7 cm.: Clearer delineation of the anomalously connected vein, disappearing in phrenico-mediastinal angle. Hypoplastic right main pulmonary artery in tracheobronchial angle. Some upper lobe veins coursing and connecting normally.

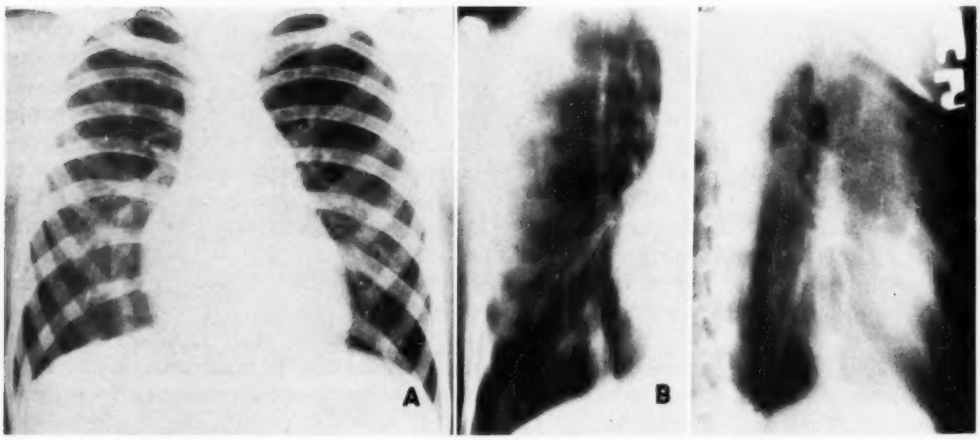
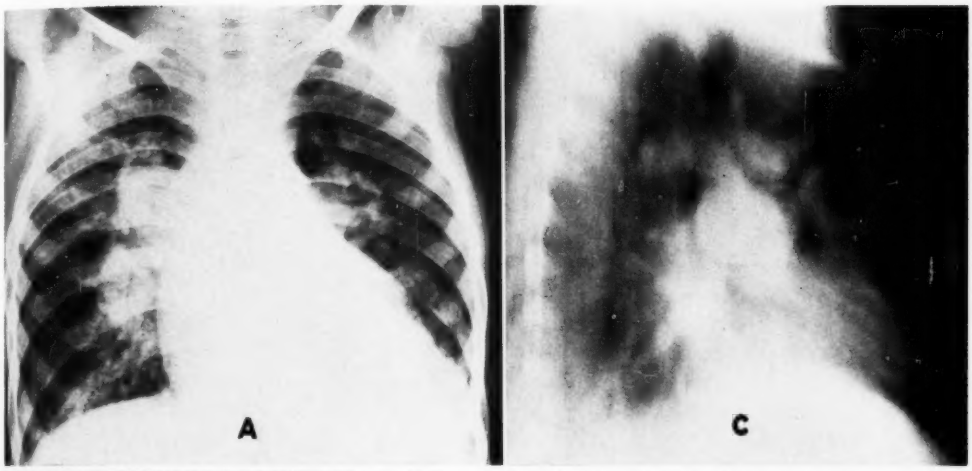


Fig. 5. Case V. One year after ligation of patent ductus arteriosus. No symptoms. Partial anomalous connection of part of right pulmonary veins to inferior vena cava.

A. Conventional postero-anterior roentgenogram: Prominent pulmonary artery segment. No evidence of increased pulmonary blood flow. A vertical, undulant vascular shadow, widening from above downward, courses from apex to base and disappears into the liver shadow. Interlobar fissure, abnormally situated, in right lower field.

B. Anteroposterior tomogram, right, 6, 5 cm.: Clearer and fuller demonstration of the anomalously connected vein, originating in upper lobe and receiving also large tributaries from the base of the lung. Some of the middle and lower lobe veins coursing normally.

C. Latero-oblique tomogram, right, 5 cm., showing the anomalous vein coursing in the midthird of the thorax.



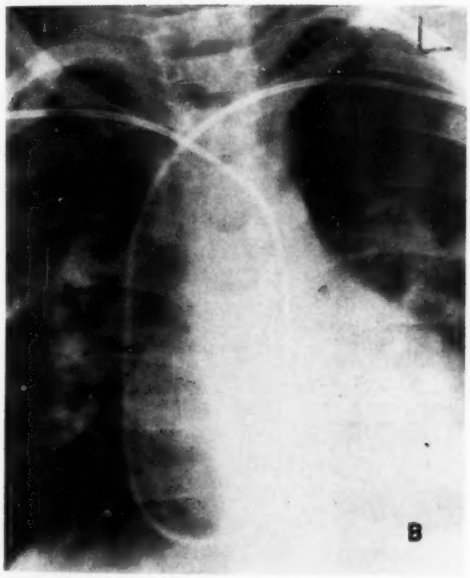


Fig. 6. Case VI. Partial anomalous connection of upper lobe veins to superior vena cava. Complete transposition of great vessels.

A. Conventional postero-anterior roentgenogram: Enlarged heart shadow and relatively narrow upper mediastinum. Pronounced increase of vascular markings in both lungs, especially marked enlargement of right hilar shadow. Diffuse opacities at left base (bronchopneumonia).

B. Spot-film during catheterization of heart (the examination had been performed two years before at another hospital in order to confirm the primary diagnosis): Catheter proves that right border of upper mediastinum is formed by lateral border of superior vena cava.

C. Latero-oblique tomogram, right, 7 cm.: In upper zone, besides enlarged vessels in the apical segment, two horizontal large vascular shadows coursing from anterior and posterior segments, respectively, toward midthorax. There is no continuity of these shadows with the pulmonary artery nor with the region of confluence of the upper lobe veins.

PERSONAL INVESTIGATIONS

1. Material

This study is based on 9 patients, 5 females and 4 males, who were examined between 1954 and 1958. The ages ranged from eight to fifty-eight years. Eight patients presented the partial type of the anomaly (Cases I–VIII), 1 the total form (Case IX).

In 1 patient (Case VI) the partial anomalous connection was associated with complete transposition of the great vessels; in another (Case V) it coexisted with a patent ductus arteriosus. In Case VII there was an atrial septal defect. The symptoms in these 3 cases were attributed to the main malformation. The remaining patients of this group were asymptomatic and the anomaly was discovered by chance.

Electrocardiographic changes were observed in 4 patients of this group: in 2 (Cases V and VI) in consequence of the principal anomaly. In the third (Case VII), with an associated atrial septal defect, there was a right bundle-branch block; the fourth (Case VIII), with bilateral partial anomalous pulmonary venous connection, showed signs of right heart hypertrophy.

The one patient with the total type (Case IX), a twenty-two-year-old female, was

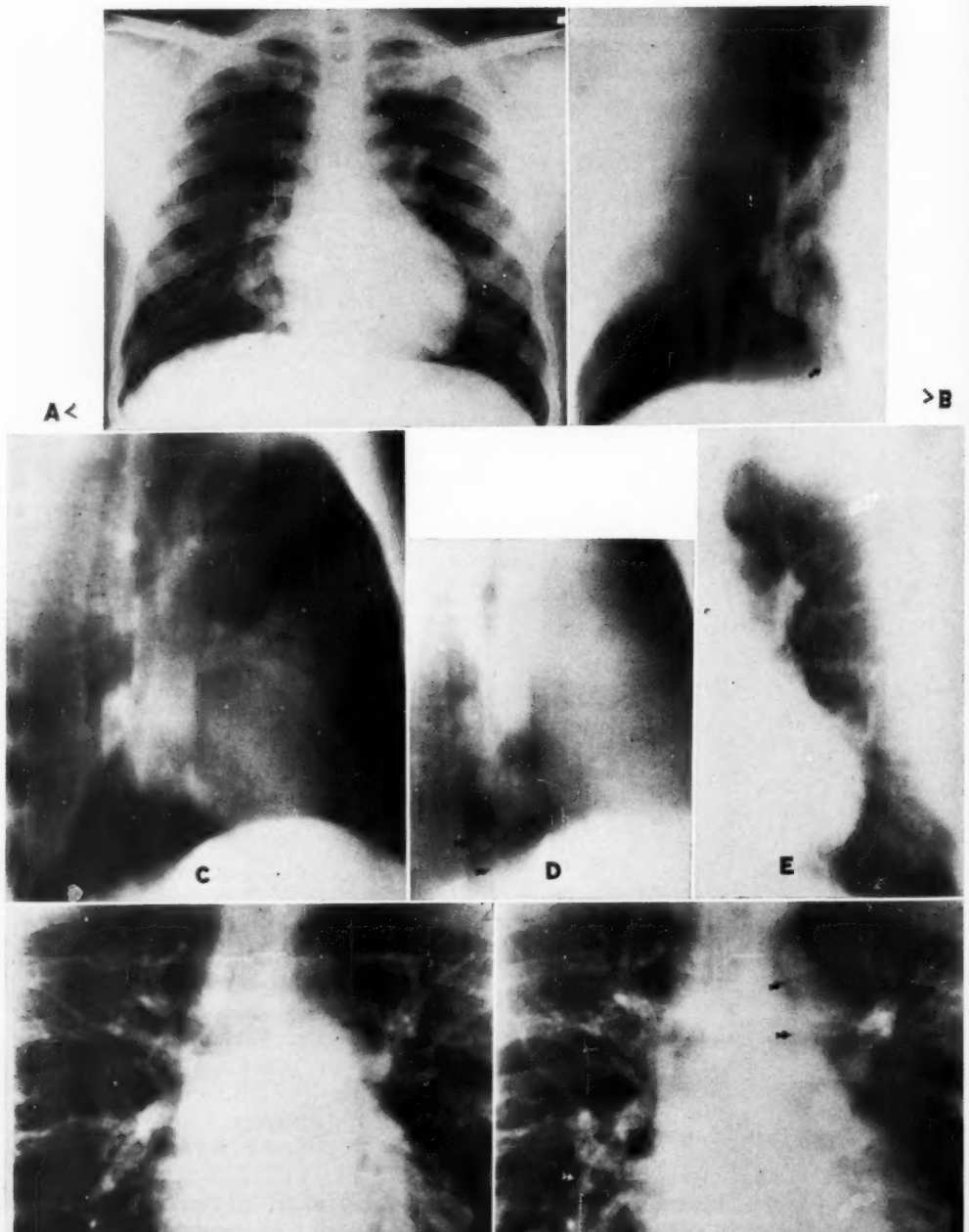


Fig. 7. Case VIII. →

known to have had a "heart lesion from birth." Her physique was that of a twelve-year-old girl. She had a nonspecific systolic murmur and a diastolic murmur of the Graham-Steele type. Her electrocardiogram showed marked right heart hypertrophy.

The clinical and electrocardiographic manifestations of all the cases are shown in Table I.

All 9 patients were examined by fluoroscopy, conventional radiography, and tomography. Catheterization of the heart was performed in 4 patients (Cases VI–IX) and intravenous angiocardiography in 2 (Cases VIII and IX).

2. *Tomographic Procedure*

The choice of the tomographic procedure depends on the result of the conventional examination. Tomographic layers are exposed as a rule in two projections.

Anteroposterior: It is not difficult, in general, to demonstrate the normally connected pulmonary veins during their course within the lung fields. In order to visualize, also, the retrocardiac part of these vessels, especially on the left side, and the region of their connection with the left atrium, a special technic has been developed (9). In addition to the usual exposure of the appropriate posterior hilar layer, we obtain a second roentgenogram with higher kilovoltage (about 12 kv). By this procedure demonstration of the retrocardiac course of the right pulmonary veins may be achieved, too, in cases with marked shift of the heart into the right hemithorax.

Latero-oblique (32): The patient is rotated from the lateral decubitus position posteriorly about 15 to 30 degrees, the degree of rotation being greater on the left side than on the right, because of the position of the heart. Owing to the rotation, tomographic sections are achieved in planes in which the mediastinal face is parallel to the film, and in consequence most of the segmental vessels are visualized in one or two "hilar layers." As a routine procedure, we prefer this technic to the lateral projection. However, this latter projection and others may be added if special topographic conditions of the lung vasculature demand them. The exposures are always made in deep inspiration, and sometimes during the Valsalva maneuver.

3. *Results*

The different anatomic forms of the anomaly, as observed in 9 patients, are

Fig. 7. Case VIII. Partial anomalous connection of part of right lung veins to right atrium and of left upper lung veins to left innominate vein *via* partially persistent left superior vena cava. Accessory pulmonary artery from abdominal aorta to right lung base.

A. Conventional postero-anterior roentgenogram: Slight increase of pulmonary vascular markings. Slight enlargement of heart shadow to the left. Right paracardial opacity with lobulated lateral border. Fluoroscopically, this opacity shows decrease of size and density during Valsalva's test; no visible pulsation could be detected. Unilateral, convex-bordered bulging of upper mediastinal shadow to the left.

B. Anteroposterior tomogram, right, 8.5 cm.: The paracardial opacity is delineated as beginning as a vertical narrow shadow in the midzone, broadening in the lower zone, then coursing medially and disappearing into the heart shadow. A second, obliquely coursing shadow, lateral to the former, but much smaller than it, is also seen (arrows).

C. Latero-oblique tomogram, right, 10 cm.: A broad, almost horizontal vascular structure, receiving tributaries from the anterior segment of the upper lobe and from the middle lobe, is visualized. This structure is in continuity with a vertical tortuous shadow below the hilus.

D. Lateral tomogram, right, 10 cm.: The angulated course of the tortuous vascular opacity and its termination at the posterior border of the heart, at the lower part of the right atrium, is demonstrated.

E. Anteroposterior tomogram, left, 7 cm.: The bulging of the left upper mediastinal shadow is sharply delineated. There is an apparent continuity of the lower contour of this opacity with the confluence of the vascular shadows adjacent to it (arrow).

F. Venous angiocardiogram, anteroposterior projection, two seconds, arterial phase: Pulmonary arteries are of normal course, size, and shape.

G. Angiocardiogram: Four seconds, venous phase: The contrast material has already entered the left side of the heart and aorta.

Right side: a vertical, wide, and varicose pulmonary vein, beginning in upper lobe, coursing paracardially downward and ending at the lower part of the right atrium (arrows); an accessory pulmonary artery, originating from abdominal aorta, coursing obliquely through diaphragm and ending at base of right lung (crossed arrow).

Left side: a partially persistent left superior vena cava, receiving tributaries from the upper lobe of the left lung (arrows); normally coursing and connecting veins draining lingula and lower lobe.

shown in the diagram (Fig. 1). The radiologic examinations are reproduced in Figures 2–8; outline drawings of some essential radiologic features are portrayed in Figures 9–11. New tomographic appearances, not hitherto reported in the literature, are described below and illustrated by some of our cases.

4. New Tomographic Appearances

Partial Anomalous Pulmonary Venous Connection, Right, to Inferior Vena Cava: In anomalous connection of right pulmonary veins to the inferior vena cava, the extent of lung tissue anomalously drained and the form of the particular "draining" vein have been outlined by means of latero-oblique tomograms (Cases I–V, Figs. 2–5). We do not intend to add to the already extensive list of descriptive appellations by naming also the various patterns revealed by the lateral projection. Instead, outline sketches of the tomographic appearances are provided (Figs. 9–11).

The trunk of the anomalously connected vein may course through the thorax in different areas. Once (Case I) it coursed through the anterior third, and four times (Cases II–V) in the mid-thorax.

The course and site of entry of some of the normally connected pulmonary veins have been delineated tomographically (36). We have demonstrated other normal veins by our anteroposterior "overpenetrated exposure" technic (2 cases) and the latero-oblique tomogram (1 case): (*a*) normal left lower lobe veins in a patient with anomalous connection of the upper lobe veins on the same side (Case VIII, Fig. 7); (*b*) normal right lower lobe veins obscured by the shadow of the displaced heart in a patient with anomalous connection of right upper lobe veins (Case I, Fig. 2); (*c*) remaining normal right upper lobe veins in a patient with anomalous connection of some upper lobe and basal veins (Fig. 4).

Associated anomalies of the pulmonary artery have been outlined by different authors, in general by angiocardiography; only once by tomography. Decrease of the pulmonary oval is described, a feature which is considered indicative of hypoplasia of the right pulmonary artery, together with absence of the shadow of the normal venous confluence. We should add that, besides this smallness of the right pulmonary artery shadow, the latero-oblique tomogram shows changes in its position which, in turn, may be responsible for the apparent change of its shape. Normally, the shadow of the right main pulmonary artery in this projection is situated in the angle between the right main and middle lobe bronchi. It presents, generally, a circular contour. In some of our patients (Case II, Fig. 3) it was situated more posteriorly, its central part being superimposed on the translucency of the right main bronchus and of oval shape. In one patient the pulmonary artery shadow was situated very low (Case I, Fig. 2). We consider that the changes of position here described are related to anomalies of bronchopulmonary distribution, so frequently associated with anomalous pulmonary venous connection.

Associated anomalies of the bronchial tree have been demonstrated radiologically by bronchography (21). We have visualized tomographically homolateral anomalous bronchial distribution, *i.e.*, mirror-image of the left side or "right-sided left lung" (21) in cases of partial anomalous pulmonary venous connection.

Accessory pulmonary arteries from the abdominal aorta have been observed by angiocardiography (21) and postmortem examination (3). In the patient with partial bilateral anomalous pulmonary venous connection (Case VIII), an accessory pulmonary artery originating in the abdominal aorta and supplying the basal part of the right lung is revealed tomographically (Fig. 7). Its site is very similar to that observed by Brown (3) and in Case II reported by Hallasz (21): an oblique coursing accessory artery situated lateral to the malconnected vein. Our finding has been proved by angiocardiography (Fig. 7, F and G).

Partial Anomalous Pulmonary Venous Connection, Right, to Superior Vena Cava: In the patient with anomalous connection of right upper lobe veins to the superior vena cava (Case VI, Fig. 6), the following triad can be distinguished: (*a*) a paramediastinal, round opacity in the lung field, (*b*) an outpouching of the mediastinal contour at this level, and (*c*) an increase of the pulmonary vascularity in the upper lobe. The round opacity in serial anteroposterior sections, a feature not yet described, is due to dilated veins in their sagittal course, draining the anterior and posterior segments of the right upper lobe, respectively, as proved by the laterooblique tomogram. Localized outpouching of the mediastinal contour at the point of entry of a malconnected vein and increased vascularization of the part of lung abnormally drained has already been observed (31).

Our case was not confirmed at catheterization because the existence of this associated anomaly was not then entertained. There are, however, reasons that support the correctness of our assumption: (*a*) no continuity is detectable between the shadows of the anomalous vessels with either the pulmonary artery or the normally situated venous confluence of the upper lobe; (*b*) if solitary pulmonary vessels are present, partial anomalous pulmonary venous connection must always be considered (36); and (*c*) the anatomy of the anomaly in our case seems to be similar to one described by Compere and Forsyth (7), from its appearance at postmortem examination. It seems worthy of mention, that partial anomalous pulmonary venous connection in complete transposition of the great vessels is one of the frequently associated anomalies that correct partially the main malformation, by diverting some pulmonary venous blood into the right side of the heart (15).

Partial Anomalous Pulmonary Venous Connection, Right, to Right Atrium: In anomalous connection of right pulmonary veins to the right atrium we observed tomographically an enlarged right hilus with disordered vascular arrangement and increased obliquity of the lower hilar vessels.

The significance of obliquely positioned vessels has been emphasized (31, 33). The enlarged hilus, as a manifestation of increased pulmonary flow, cannot be considered indicative of anomalous pulmonary venous connection in our case, since there coexists an atrial septal defect. The disordered vascular arrangement, as the third component, is, in our opinion, worthy of further tomographic investigation, which is likely to reveal an underlying pattern characteristic of anomalous connection of right lung veins to right atrium. In another patient with this type of the anomaly (Case VIII, Fig. 7), the plain roentgenogram showed a paracardiac opacity of polycyclic border which was identified tomographically as a dilated malconnected vein. The appearance of the vein in the plain film is similar to the one illustrated by Findlay and Maier (14), apart from the greater width and polycyclic outline in our case. This latter feature most probably indicates a congenital varicose dysplasia of the malconnected vein (36). The possibility of an arteriovenous aneurysm has been excluded by tomography and angiocardiography.

From an anatomical point of view, our case would appear to be similar to the case observed by Hwang *et al.* (24) which showed partial bilateral anomalous pulmonary venous connection (right to right atrium, left to left innominate vein *via* partially persistent left superior vena cava).

Partial Anomalous Pulmonary Venous Connection and Total Anomalous Pulmonary Venous Connection to Left Innominate Vein via Partially Persistent Left Superior Vena Cava: In anomalous connection of left upper lobe veins (Case VIII) we have demonstrated by tomography and confirmed by angiocardiography continuity between the left upper lobe veins and the partially persistent left superior vena cava and normal course and

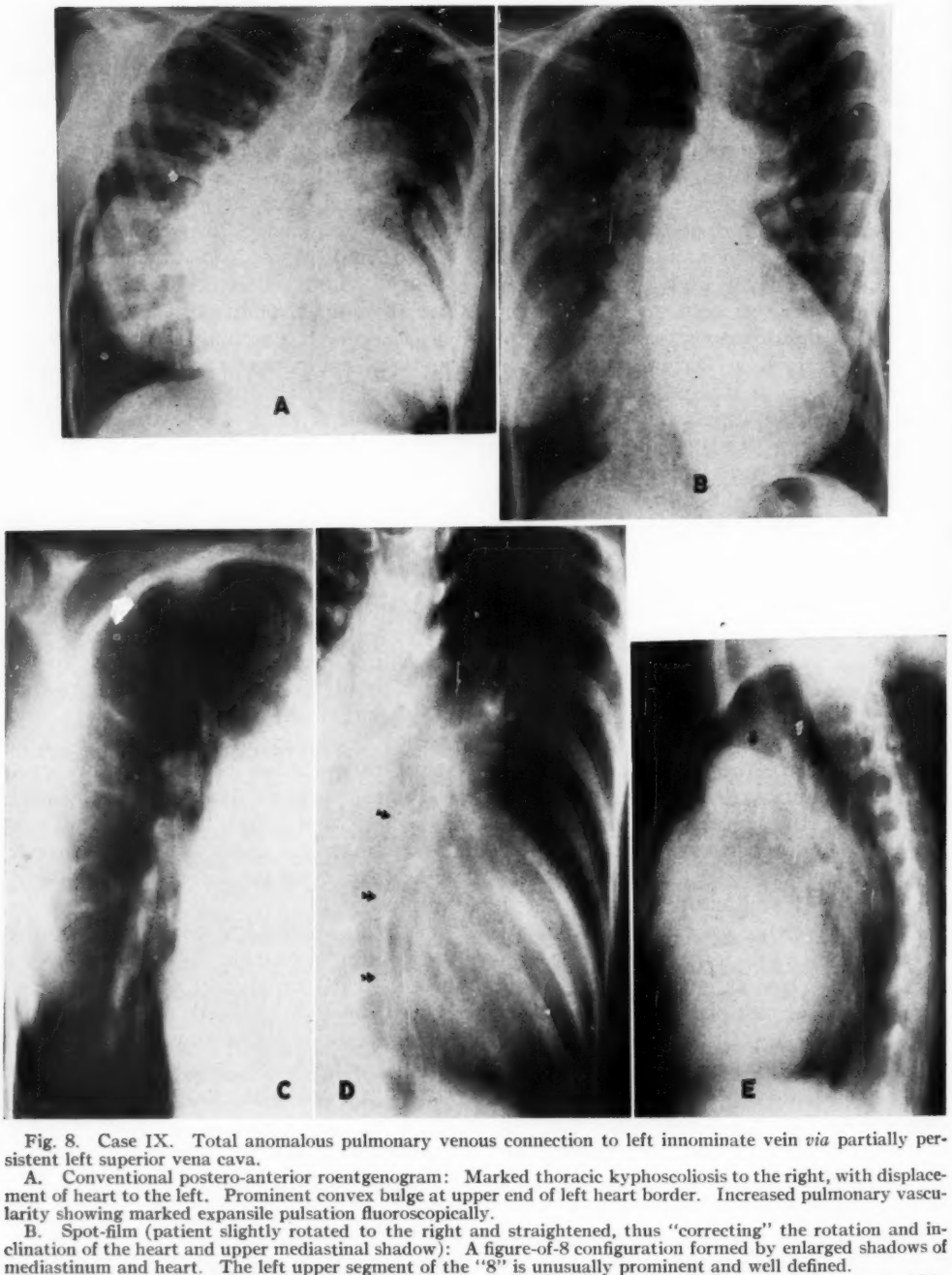


Fig. 8. Case IX. Total anomalous pulmonary venous connection to left innominate vein *via* partially persistent left superior vena cava.

A. Conventional postero-anterior roentgenogram: Marked thoracic kyphoscoliosis to the right, with displacement of heart to the left. Prominent convex bulge at upper end of left heart border. Increased pulmonary vascularity showing marked expansile pulsation fluoroscopically.

B. Spot-film (patient slightly rotated to the right and straightened, thus "correcting" the rotation and inclination of the heart and upper mediastinal shadow): A figure-of-8 configuration formed by enlarged shadows of mediastinum and heart. The left upper segment of the "8" is unusually prominent and well defined.

C. Anteroposterior tomogram, right, 8 cm.: Pulmonary artery and branches of moderately increased width, but of normal pattern. Pulmonary veins relatively small; their point of convergence is more to the left than normal.

D. Anteroposterior tomogram, left, 5 cm.: Lower pulmonary veins all coursing vertically and parallel to the pulmonary artery toward upper part of the hilus (arrow). Confluence of upper pulmonary veins in proximity to the upper segment of the "figure-of-8."

E. Latero-oblique tomogram, left, 6 cm.: Oval, pear-shaped opacity in the anterior mediastinum, apparently receiving venous tributaries (arrow). Hypoplasia of left lower lobe.

Catheterization of the heart and venous angiocardiography proved the diagnosis.

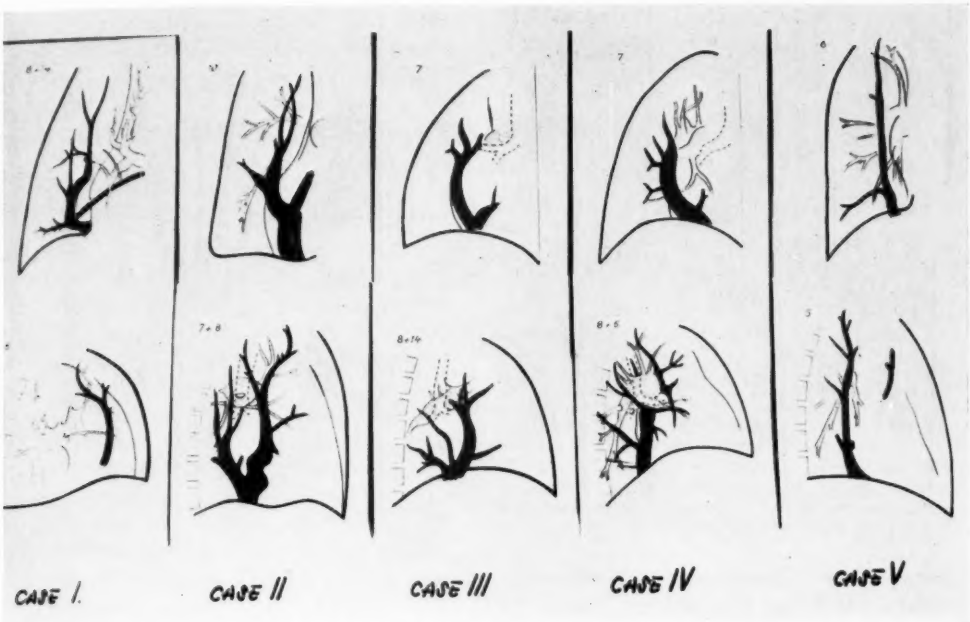


Fig. 9. Outline drawings of tomograms of Cases I–V, showing some essential radiological features in anomalous connection of right lung veins to inferior vena cava.

connection of the lower lobe veins of the same side (Fig. 7). On the other hand, in the patient (Case IX) with total anomalous pulmonary venous connection, the anomalous course and connection of the lower lobe veins could be visualized by tomography (Fig. 8). Decrease of volume of left lower lobe, indicating hypoplasia, has been demonstrated in the same case (Fig. 8). Hypoplasia of lung lobes, so far as we have been able to determine, has been reported in the literature only in the partial form of anomalous pulmonary venous connection.

A partially persistent left superior vena cava may be present in partial anomalous pulmonary venous connection as well as in the total form. The radiographic appearance of this vessel in the postero-anterior roentgenogram is well known. We would draw attention to its localization by the latero-oblique tomogram. The oval-shaped opacity, representing this more or less dilated "connecting vein," may be situated either in the mid-thorax (Case VIII, Fig. 7) or in the anterior third (Case IX, Fig. 8). These topographical variants are also to be discerned in the catheter and angiographic examinations of other authors (Kjellberg *et al.*, T.A. 470220 and M.M. 460108, (27); Levin and Borden, Case II, (28); Whitaker, Cases II and IV, (39)).

APPRAISAL OF TOMOGRAPHY IN ANOMALOUS PULMONARY VENOUS CONNECTION

As shown by the cases illustrated, the value of tomography lies in its ability to detect the presence of anomalous pulmonary venous connection, to visualize its detailed morphology, and to demonstrate associated bronchopulmovascular malformations.

The presence of anomalous pulmonary venous connection may be *detected*, when anomalous vascular shadows are absent from the conventional roentgenogram. The demonstration may be direct, by visualizing a vascular shadow of abnormal course and connection, or indirect, by proving the absence of some or all normal pul-

Fig. 10. Outline drawings of tomograms of Cases VI–VIII, showing some essential radiological features in anomalous connection of right lung veins to superior vena cava and right atrium, respectively.

monary veins. The tomographic detection assumes particular importance when the anomaly is associated with other cardiovascular malformations.

The efficiency of tomography *in visualizing particular morphological details* has been illustrated. The procedure may delineate clearly a disordered pulmonary vascular pattern, the regions drained by the anomalous vein, the areas of lung traversed by it, the site of connection, the width and the shape of the vessel. We wish to point out the special value of the latero-oblique projection in demonstrating the lung territories drained by the anomalous vein as well as its course and shape, details which are of importance to the surgeon. In this connection, it is also worthy of mention that the width of the anomalous vein together with the extent of anomalously drained lung may afford an estimate of the volume of blood returning to the right heart. The estimation of this factor is not always feasible in the cardiac laboratory.

Evidence of *anomalies of the pulmonary artery*, the *bronchial tree*, or the *lung lobes* lends weight to the provisional diagnosis, when anomalous pulmonary venous connection is suspected, or may arouse suspicion of this anomaly, even when no abnormal pulmonary vein is detected in the routine examination.

Fig. 11. Outline drawings of tomograms of Cases VIII and IX, showing some essential radiological features in anomalous connection of left lung veins and all lung veins, respectively, to left innominate vein *via* partially persistent left superior vena cava.

Although, as has been shown, a surprisingly detailed anatomic diagnosis can be achieved by tomography, it cannot be relied upon alone if surgical treatment of this anomaly is planned, because not all forms of anomalous pulmonary venous connection can be demonstrated by tomography. Furthermore, the presence of any associated malformation, the most common of which is atrial septal defect, can only be elucidated by other means. Therefore, when surgery is contemplated, this double need for clarification requires, in addition, cardiac catheterization and angiocardiography.

SUMMARY

The radiological appearances of anomalous pulmonary venous connection in conventional and tomographic roentgenograms, as described in the literature, are reviewed. The diverse signs are grouped

into changes in the lung fields and hilar regions, the upper mediastinum, the heart and great vessels, and other thoracic structures. Few reports of the use of tomography in the diagnosis of this condition were found, and then only with regard to the anomalous connection of a right pulmonary vein with the inferior vena cava.

The tomographic method, including a new technic for viewing the retrocardiac part of the pulmonary veins, has been extensively applied to 9 patients. There were 4 different types of the partial, and 1 of the total form of this anomaly. Additional radiological appearances, not hitherto reported, have been defined and illustrated from the material.

Emphasis is laid on the value of tomography in detecting the presence of anomalous pulmonary venous connections, in visualizing the detailed morphology, and in demonstrating associated bronchopulmovascular malformations.

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Government Hospital
Tel-Hashomer, Israel

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SUMMARIO IN INTERLINGUA

Le Diagnose Radiologic de un Anormal Connexion Pulmono-Venose: Un Studio Tomographic

Anormal connexion pulmono-venose es un malformation congenite in que un del venas pulmonar o plures o omnes disbucca a in le atrio dextere o un de su tributarios. Le condition pote esser partial o complete.

Es presentate un revista del apparentia radiologic de anormal connexion pulmono-venose in roentgenogrammas conventional e tomographic secundo le descriptiones in le litteratura. Le varie signos es gruppate in alterationes in le campos pulmonar e le regiones hilar, alterationes del mediastino superior, alterationes del corde e del grande vasos, e alterationes del remanente structuras thoracic. Pauc reportos del uso de tomographia in le diagnose de iste condition esseva trovate, e illos que esseva trovate concerneva solmente le connexion anormal del vena dextero-pulmonar con le vena cave inferior.

Le methodo tomographic, incluse un nove technica pro le visualisation del parte retrocardiac del venas pulmonar, esseva applicate extensemente a 9 patientes. Esseva representate in le serie 4 differente typos del anormalitate partial e un del forma total. Apparentias radiologic additional non previemente reportate, es definite e illustrate ab materiales colligite in le presente studio.

Es sublineate le valor de tomographia in le detection del presentia de anormal connexion pulmono-venose, in le visualisation del detalios de su morphologia, e in le demonstration de associate malformationes broncho-pulmono-vascular.

Rotation of the Kidney Around Its Transverse Axis[1]

BELA GONDOS, M.D.[2]

DISPLACEMENT of the kidney, no matter what its underlying cause, is generally associated with rotation. In most cases, an evaluation of the origin and direction of the displacing force can be made without any difficulty. While this force, usually induced by a space-occupying mass, may not be great enough to result in significant displacement, it may be sufficient to produce a rotation of the kidney. Rotation may occur around any of the three axes; generally it is around two or all three, with one being predominant. The main purposes of the study reported here were to show how rotation of the kidney may be demonstrated on anteroposterior films of the abdomen as well as on urograms, and to investigate its significance in the localization of abdominal masses.

For evaluation of its diagnostic value, the physical factors precipitating rotation should be understood. Rotation around the sagittal axis is generally obvious on a roentgenogram, and its recognition does not cause any difficulty. This is not true of rotation around the vertical or transverse axis. In an analysis of the physical factors playing a part in rotation, each type of rotation should be examined separately. The present paper deals with rotation around the transverse axis of the kidney.

REVIEW OF LITERATURE

In a well documented paper, Mertz and Hamer (8) discussed in 1934 the recognition of rotation of the kidney on the basis of lateral (retrograde) pyelograms. They presented cases of rotation around the transverse axis in such conditions as hypernephroma occupying the middle and lower thirds of the left kidney, solitary cyst of the lower pole of the left kidney, empyema of the gallbladder, and myxosarcoma of the pancreas. The last case is of particular interest because neither in the literature nor in the author's material could there be found a case in which rotation around the transverse axis was precipitated by a pancreatic mass.

Weyrauch (14) pointed to the role of the vascular pedicle in rotation of the kidney: "If the pedicle is short, the point of its renal insertion remains fixed and evidently serves as a fulcrum during rotation." According to Weyrauch, "it is impossible to localize a mass to the peritoneum, the retroperitoneum or the kidney proper on the basis of the type of torsion which is found." He presented examples of rotation of the kidney produced by enlargement of the liver, of the spleen, and by a perinephritic abscess.

Schulte and Emmett (13), reviewing a group of 112 retroperitoneal tumors, found that the pancreatic tumors caused displacement of the kidney, ureter, or both in only 5.5 per cent, whereas such displacement occurred with 72.5 per cent of the other retroperitoneal tumors. No mention of rotation of the kidney was made in this paper.

Sporadic case reports of displacement of the kidney due to enlargement of the liver, the gallbladder, and spleen appear in the literature from time to time (Givner, (4); Braasch and Emmett, (2); Engel, (3); Poutasse, (11); Bell, Heublein, and Hammer, (1); etc.). The illustrations accompanying these interesting reports show, in addition to displacement, evidence of rotation around the transverse axis of the kidney.

RECOGNITION ON THE ANTEROPOSTERIOR ROENTGENOGRAM

Rotation of the kidney around the transverse axis is readily demonstrable on the

[1] From the Department of Radiology, D. C. General Hospital, Washington, D. C. Accepted for publication in January 1959.

[2] Chief, Department of Radiology, D. C. General Hospital, Washington, D. C., and Assistant Clinical Professor of Radiology, Georgetown University School of Medicine.

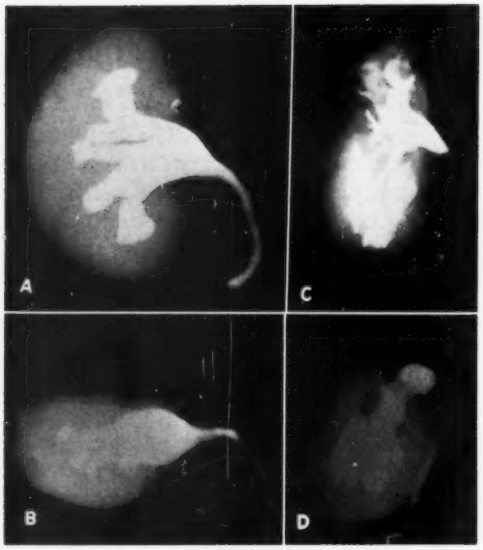

Fig. 1. Roentgenograms (pyelograms) of two kidney specimens.
A. First kidney, anteroposterior view.
B. First kidney, axial view (after 90° rotation around the transverse axis); the anterior surface looks upward.
C. Second kidney, anteroposterior view.
D. Second kidney, axial view (after 90° rotation around its transverse axis); the anterior surface looks upward.
The anteroposterior roentgenogram shows the normal bean shape of the kidney image (A and C). In the axial view the long axis of the kidney and of the calyceal system appears markedly shortened, the ureteropelvic junction occupies a high position, the "lower pole" (actually the posterior surface) is wide and blunted as compared with the gradual tapering of the margins in the anteroposterior view. The concavity of the hilus is not recognizable in the axial view.

lateral view of retrograde pyelographic studies, but that view is not routinely obtained. Recognition on excretory urograms is of greater importance because of their wider application; however, an interpretation of the lateral view may be difficult and is sometimes impossible because the density of the opaque medium in the urinary passages may be inadequate for evaluation in this projection, as emphasized by Narath (10).

On anteroposterior abdominal films and urograms, rotation around the transverse axis is commonly ignored or incorrectly interpreted. If of significant degree, however, it can be easily recognized, and the axis of rotation can be identified. It is one of the purposes of this paper to demonstrate the respective roentgen manifestations.

In order to illustrate the changes in the kidney image and on the pyelogram (urogram), roentgenograms of two kidney specimens in two different projections were obtained (Fig. 1). Between the projections of the two extreme positions, variable degrees of rotation may occur, with corresponding changes in the size and shape of the kidney image and in the pyelogram. For an understanding of the high position of the ureteropelvic junction in the axial view, the anatomy of the kidney pelvis should be recalled. The axis of the kidney pelvis in a normal person generally lies between the frontal and sagittal planes. In other words, the ureteropelvic junction is located more anteriorly than the calyces and the kidney pelvis.

Figure 2 is the left retrograde pyelogram of a patient in whom the space-occupying force acted in the caudocranial direction. On the anteroposterior view, a "deformity" similar to that demonstrated on the study of the kidney specimens (in the superior-inferior projections) is shown; a lateral film proves that this "deformity" is the result of rotation around the transverse axis.

Figure 3 is another example of rotation around the transverse axis. The diagnosis in this instance can be made by comparison with a film taken before rotation took place. This patient had recurrent kidney stones in an infected kidney. The stones had been removed by pyelotomy, which was followed by prolonged drainage. The surgical wound healed with a wide scar, in which—actually in an incisional hernia—the upper pole could be distinctly palpated. The palpatory findings, the considerable decrease of the length of the kidney image, and the typical changes on the urogram, left no doubt that the upper pole was tilted posteriorly (and the lower anteriorly).

With employment of the criteria discussed above, 9 cases of kidney rotation of significant degree around the transverse axis were observed in the District of Columbia General Hospital during the last

two years. Rotation of lesser degree was occasionally seen and probably a large number of cases of rotation of slight degree went unnoticed. Two cases were added from other sources. The experiences discussed in this paper are based on this material.

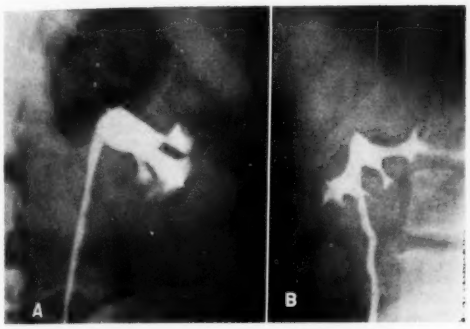

Fig. 2. Retrograde pyelogram (anteroposterior and lateral). The patient had three cysts (observed on surgery) on the upper pole of the left kidney.

Note the short longitudinal diameter of the calyceal system in the anteroposterior view and also the high position of the ureteropelvic junction. Compare with B and D in Fig. 1. (Lateral view indicates the long axis of the calyceal system, showing that the lower pole is markedly tilted anteriorly, the result of rotation around the transverse axis.)

CAUSE AND MECHANISM

The kidney is held in its position by the fatty capsule, the renal (Gerota's) fascia, the support of adjacent organs, and the intra-abdominal pressure, as well as by the vascular pedicle. The mobility and consequently the position of the kidney are also considered to be related to the shape and the depth of the renal fossa. The adjacent organs and the renal pedicle are probably the most important physical factors in the rotation of the kidney.

An increase in size of one or more of the adjacent organs, or a change in their position, may cause encroachment upon the space available for the kidney, this effect being especially obvious if a true mass is present. As a fairly movable organ, the kidney tries to accommodate itself with a shorter diameter in the direction of encroachment. If the available space is diminished in a diameter conforming with

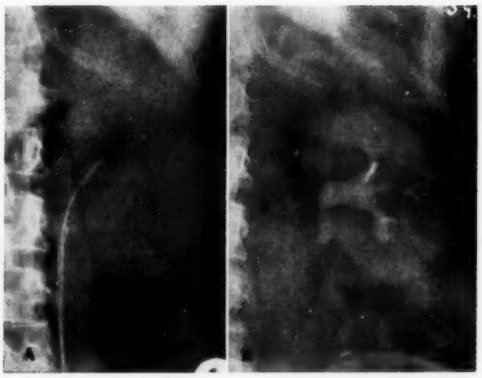

Fig. 3. Roentgenograms of the left kidney. The patient underwent surgery and subsequent prolonged drainage of the left kidney. A. Before surgery. B. Urogram after surgery.

Note the considerably shortened longitudinal axis of the kidney and of the calyceal system, and the highly positioned ureteropelvic junction in B. The kidney is rotated around the transverse axis. On palpation, the upper pole—dropping backward into the hernial sac of the abdominal wall—was easily palpable and ballotable.

the long axis of the body, the kidney will respond with rotation around its transverse axis, placing itself with its shorter diameter in that direction. The vascular pedicle acts in this process as a fulcrum, as emphasized by Weyrauch (14). A review of our material indicates that this rotation occurs with the lower pole tilted anteriorly. Similar observation has also been made by Mertz and Hamer (8), Morton (9), and Rolnick (12). The almost exclusive direction of rotation with the lower pole tilted anteriorly can be explained by the difference between the physical factors prevailing in the upper abdomen and those in the lower. The rigid thoracic wall and the more solid structures (liver, spleen, and possibly the pancreas) of the upper abdomen put a greater limitation upon an anterior displacement of the upper pole than do the more elastic structures (muscular abdominal wall and the bowels) of the lower abdomen upon displacement of the inferior pole when this rotates anteriorly. The different length of the vascular pedicle probably explains why rotation occurs in one person and not in other individuals, despite otherwise

Fig. 4. Urogram of a patient with marked ptosis of the right kidney. A. Patient supine. The right kidney shows evidence of rotation around the transverse axis. B. Patient prone. The rotation is more marked.

similar anatomical and topographic-anatomical circumstances.

The role of gravity is indicated by the increase of rotation produced by positional changes. In 3 of our 9 patients, the rotation became more marked after turning from the supine to a prone position (Figs. 4 and 5). The relatively common occurrence (5 of 9 in this material) of this type of rotation in ptosis (Fig. 4) is probably also related to the effect of gravity. In one patient it was observed after nephropexy.

The peritoneum has no significant role in rotation. Attempts to localize an abdominal mass with reference to its intra- or retroperitoneal position have been unsuccessful. It seems that in the present consideration it is better to speak in terms of a space-occupying force and its direction rather than of an abdominal mass and its relationship to the peritoneum. It is the direction of the encroachment on the space available for the kidney which determines the axis of rotation of the kidney. In rotation around the transverse axis, the space-occupying force works in the vertical axis of the body. In this respect it makes no difference whether the liver, gallbladder, spleen, or adrenal is the enlarged organ. Nor is there any essential difference with regard to the encroachment on the space whether the mass is adjacent to the upper or lower pole or represents a tumor of the kidney itself.

CLINICAL APPLICATION

Rotation around the transverse axis may be a useful sign in recognition and localization of abdominal masses. Correct identification of the axis, however, is prerequisite to the usefulness of the sign. This type of rotation is relatively common in tumors of the kidney located either in the upper (Fig. 2) or in the lower pole, and in cases of a mass adjacent to one of the extremities of the kidney. In Figure 5, space encroachment in the vertical (caudocranial) direction resulted in rotation of the kidney. If the tumor is located in or adjacent to the upper pole, the blunted "inferior pole" (actually the posterior surface) may create an incorrect impression that the tumor is in the lower pole.

It is known that adrenal tumors, if they reach a significant size, often produce downward displacement of the kidney (Kaplan and Greene, (7); Joelson,

Fig. 5. Urogram of a patient having a large fibroid tumor of the uterus (the size of a six-month pregnancy).
A. Anteroposterior view. The right kidney is rotated around the transverse axis. It is "pushed" against the lower surface of the liver. Note the mass emerging from the pelvis and the calcification within it.
B. Postero-anterior view, with the patient prone. The rotation becomes more marked.

Persky and Rose, (5); Poutasse, (11); Engel, (3); etc.). Little attention is directed in the literature to the associated rotation. The "bent stem" or "lily of the valley" appearance of the pyelogram described by Engel is the result of rotation around the transverse (and sagittal) axis. Engel believes that this appearance rather typically occurs in cases of enlarged liver or spleen. In the author's experience it is not a specific sign of an enlargement of any organ. In addition to enlargement of the liver (Fig. 6) and spleen, it may accompany that of the gallbladder (hydrops or empyema) and is relatively common in cases of adrenal tumors.

It may be concluded that rotation of the kidney around its transverse axis, while not an indication of an abdominal tumor, should arouse suspicion in this direction and initiate a search for the cause. A displacement may not be marked enough to be considered pathological, but an associated rotation may add to its significance. More importance can be attached to rotation around the transverse axis when it is associated with proximal displacement of the kidney.

Recognition of rotation is also important in eliminating a possibly incorrect interpretation of changes in the shape and size of the kidney. Blunting of the "lower pole" may be thought to be a deformity, and a tumor or cyst may erroneously be considered. The decreased length of the kidney image resulting from rotation of this type may also be misinterpreted as actual decrease in the size of the kidney and an incorrect diagnosis of contracted or hypoplastic kidney may be made. Accurate evaluation regarding the size and the shape of the kidney cannot be made unless rotation has been excluded.

In 3 of our cases a mass was felt in the abdomen. Two of these cases are shown in Figures 6 and 7. Further studies failed to reveal any tumor of the abdominal organs. Obviously, the anteriorly displaced inferior pole represented the "palpable mass." Kaminsky and his asso-

Fig. 6. Urogram, of a patient with a large liver, from an unknown cause. An "abdominal mass" was palpated on the right. A. Anteroposterior view. B. Right lateral view.
Note evidence of rotation of the right kidney. The lateral film well visualizes the anterior tilting of the lower pole. The "palpable mass" actually was the lower pole of the right kidney.

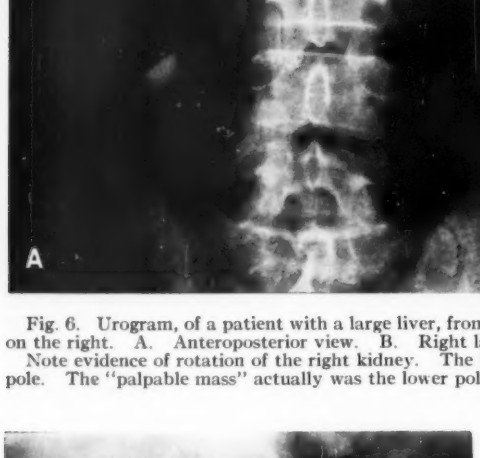

Fig. 7. This patient had a "palpable mass the size of an egg," obviously the anteriorly displaced lower pole, felt on palpation. The right kidney shows the characteristic image of rotation around the transverse axis. There is also moderate ptosis of the right kidney.

ciates (6), in a study of 241 cases of abnormal (more than 5 cm.) renal mobility, reported a palpable mass as a presenting symptom in 2 per cent. It is possible that in this percentage of palpable masses the ptotic kidney also underwent rotation around the transverse axis, as in our cases. This may explain the palpatory finding. In the case illustrated in Figure 7, the palpable mass ("the size of an egg") was distinctly different from that usually felt in kidneys without any rotation. The anteriorly displaced inferior pole is not only more easily palpated but may also provide a palpatory finding of different quality from that of a nonrotated kidney.

SUMMARY

Rotation of the kidney of significant degree around its transverse axis may generally be recognized on anteroposterior roentgenograms of the abdomen or on urograms. It is manifested in a shorter roentgen image of the kidney, blunting of the "lower pole," shorter longitudinal diameter of the calyceal system, and a higher position of the ureteropelvic junction. The rotation occurs almost always with the lower pole displaced anteriorly. Rotation around the transverse axis may also result in a "palpable mass" in the renal region; the "mass" is produced by the anteriorly displaced lower pole.

Rotation may be an indication of encroachment on the intra-abdominal (both intra- and retroperitoneal) space in the vertical direction, brought about by a mass which is either adjacent to the upper or lower pole of the kidney or by one which represents a tumor of the kidney itself.

Such an encroachment may also be the result of an enlargement of the liver, gallbladder, or spleen.

Rotation around the transverse axis is rather commonly associated with ptosis of the kidney and has also been observed following surgical mobilization of the kidney and after nephropexy. It should not be confused with abnormally small (contracted or hypoplastic) kidney or with a renal cyst or tumor.

Rotation should be excluded when the size and shape of the kidney are to be evaluated on the basis of an anteroposterior roentgenogram.

NOTE: The author is indebted to Peter A. Narath, M.D., New York, N. Y., for his permission to include one of his cases in this paper. Another patient was operated on by the late Henrik Szöllös, M.D., Budapest, Hungary.

1720 Connecticut Ave., N. W.
Washington, D. C.

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SUMMARIO IN INTERLINGUA

Rotation del Ren Circum Su Axe Transversal

Novem casos de rotation del ren circum su axe transversal a grados significative esseva observate al Hospital General del Districto de Columbia in un periodo de duo annos. Casos de rotation a grados minus pronunciate esseva vidite occasionalmente, e il es probabile que un grande numero de casos de leve grados de rotation non esseva notate.

Rotation del ren circum le axe transversal a grados significative es generalmente recognoscibile in roentgenogrammas anteroposterior del abdomine o in urogrammas. Illo es manifeste in un plus curte imagine roentgenographic del ren, obtusitate del "polo inferior," un plus curte diametro del systema calycee, e un plus alte position del junction ureteropelvic. Le rotation occurre quasi semper in le presentia de un displaciamento anterior del polo inferior. Illo pote resultar in le presentia de un "massa palpabile" in le region renal, producite per le displaciamento anterior del polo inferior.

Le rotation pote esser un indication pro le presentia de un fortia intrusional intra le spatio abdominal in direction vertical, e iste fortia pote esser le effecto de un massa adjacente al polo superior o inferior del ren o locate intra le ren, sed le fortia pote etiam esser le effecto de un allargamento del hepate, del vesica biliari, o del splen. Illo es associate satis communmente con ptosis del ren e ha essite observate como sequella del mobilisation chirurgic del ren post nephropexia. Illo non deberea esser confundite con un anormalmente micre ren o con un cyste o tumor renal.

Rotation del ren debe esser excludite ante que on utilisa un roentgenogramma anteroposterior como base de un evalutation del conformation e del dimensiones del ren.

Radiologic Aspects of Stab Wounds of the Chest[1]

LEONARD C. DOUBLEDAY, M.D.

THE PURPOSE of this paper is to describe the significance of initial roentgenograms following stab wounds of the thorax and to emphasize the importance of follow-up examinations in certain circumstances. The material is dealt with under three topographical areas: supraclavicular and mediastinal; pericardial; lower thoracic.

SUPRACLAVICULAR AND MEDIASTINAL WOUNDS

Stab wounds of the supraclavicular region may be quite deceptive to the clinician on cursory examination; yet a roentgenogram of the chest, usually ordered to determine whether or not pneumothorax is present, may demonstrate widening of the superior mediastinal shadow resulting from hemorrhage into the mediastinum. Hemomediastinum leads rapidly to compression of the great veins and the atria of the heart, having the same effect as acute cardiac tamponade. Usually, as pressure in the mediastinum mounts, the mediastinal pleura ruptures and associated hemothorax develops.

CASE I: A 34-year-old colored male sustained a stab wound of the left supraclavicular region. There was no evidence of shock and he was in good general condition. A chest film taken for assessment of possible pneumothorax (Fig. 1, A), showed widening of the superior mediastinal shadow, particularly on the left side, and separation of the fundus of the stomach from the base of the left lung. These changes were interpreted as indicating hemomediastinum and hemothorax at the left base. Surgical exploration of the supraclavicular area showed that the subclavian artery had been damaged, and a branch just distal to the thyrocervical trunk had been severed completely. Profuse bleeding occurred, requiring thoracotomy for control. Twelve hundred cubic centimeters of blood was removed from the pleural cavity and the mediastinum. Figure 1, B shows the appearance of the chest one week later; the mediastinum was now normal in appearance, with residual pneumohemothorax.

Comment: It should be noted that the changes at the left base represent blood collected beneath the base of the left lung, rather than an elevation of the left leaf of the diaphragm, which could be postulated on the basis of proximity of the wound to the phrenic nerve.

The diagnosis of hemothorax is based on the finding of significant separation of the fundus of the stomach (as outlined by gas in the stomach) from the air-filled base of the lung. This is not an uncommon finding in hemothorax and can be confirmed in cases of doubt by an anteroposterior supine film of the chest. In this projection the blood will be seen to have become dispersed over the surface of the lung if the shadow indeed represents blood beneath the pulmonary base.

This same appearance may occasionally be seen in routine chest films of normal children and, in rare instances, in normal adults, due to interposition of the left lobe of the liver, spleen, or splenic flexure of the colon between the fundus of the stomach and the left leaf of the diaphragm (Fig. 1, C and D). The finding, however, is usually of significance, representing either fluid at the base of the lung or a lesion interposed between the stomach and the diaphragm, *e.g.*, subphrenic abscess.

CASE II: A 40-year-old colored male entered the hospital immediately after being stabbed by an ice pick in the right upper chest. Although the patient was in shock, the clinical findings referable to the heart and chest were within normal limits. An admission film demonstrated widening of the mediastinal shadow to the right, indicating hemomediastinum without evidence of pneumothorax or hemothorax. The cardiac silhouette was considered within normal limits for an anteroposterior supine projection of the chest. The patient died six hours after admission. At autopsy, approximately 1,500 c.c. of bloody fluid was found in the right pleural cavity, 600 c.c. of serosanguineous fluid

[1] From the Department of Radiology, College of Physicians and Surgeons, Columbia University, and the Radiological Service, Columbia-Presbyterian Medical Center, New York, N. Y. Accepted for publication in January 1959.

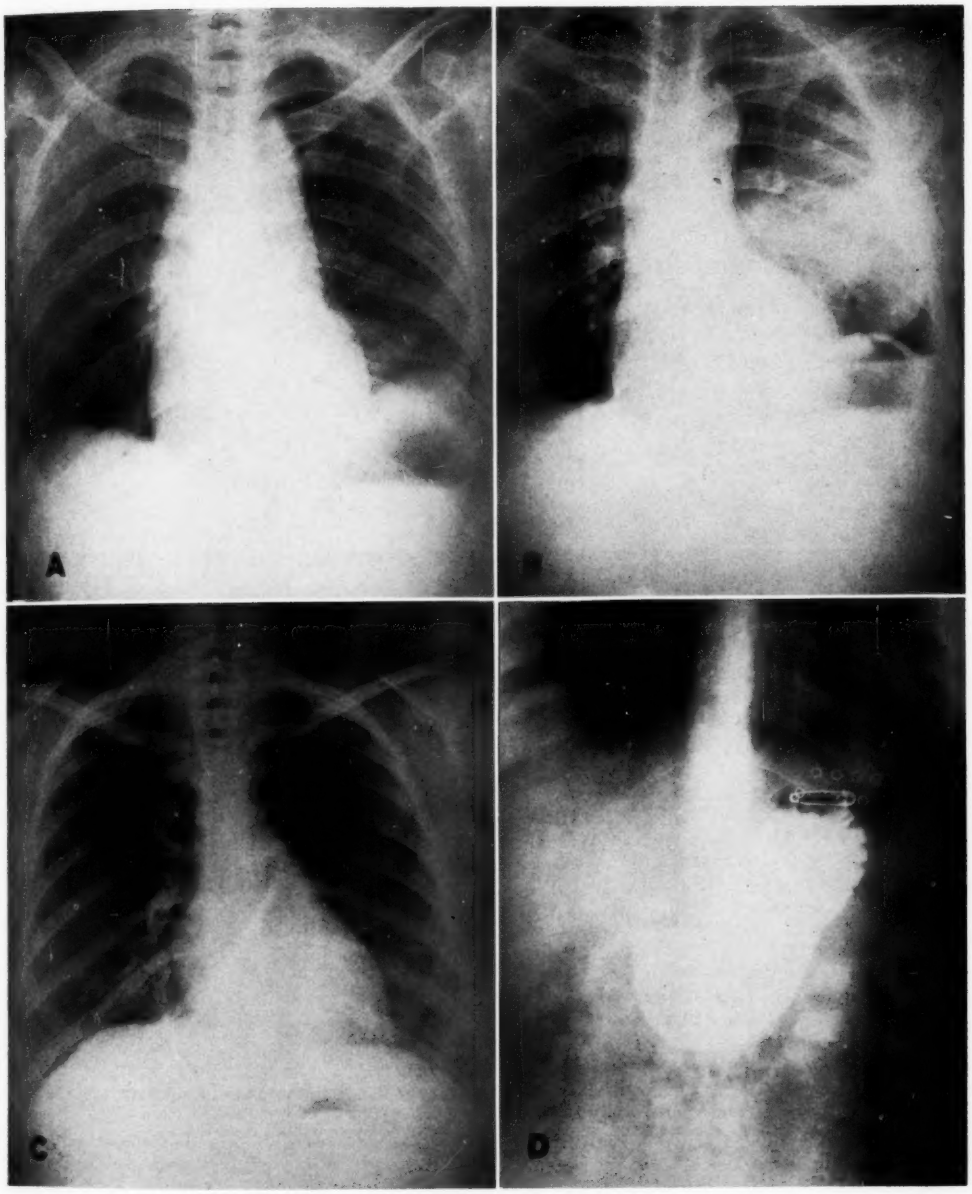

Fig. 1. Case I. A. Widening of superior mediastinum to the left. Blood collected beneath the base of the left lung. B. Normal appearance of mediastinum one week after injury.
C and D (for comparison). Interposition of spleen and splenic flexure between fundus of stomach and diaphragm in a normal adult, confirmed by diagnostic pneumoperitoneum with the stomach filled with barium.

in the left pleural cavity, and about 100 gm. of bloody clots and 100 c.c. of bloody fluid in the pericardial sac. The stab wound had penetrated the pericardial sac and the aorta. Most of the bleeding was found to have been in the tissues surrounding the aorta.

Comment: The chest film on admission to the hospital demonstrates the difficulty of diagnosis of hemopericardium. Though blood in the pericardial sac was suspected,

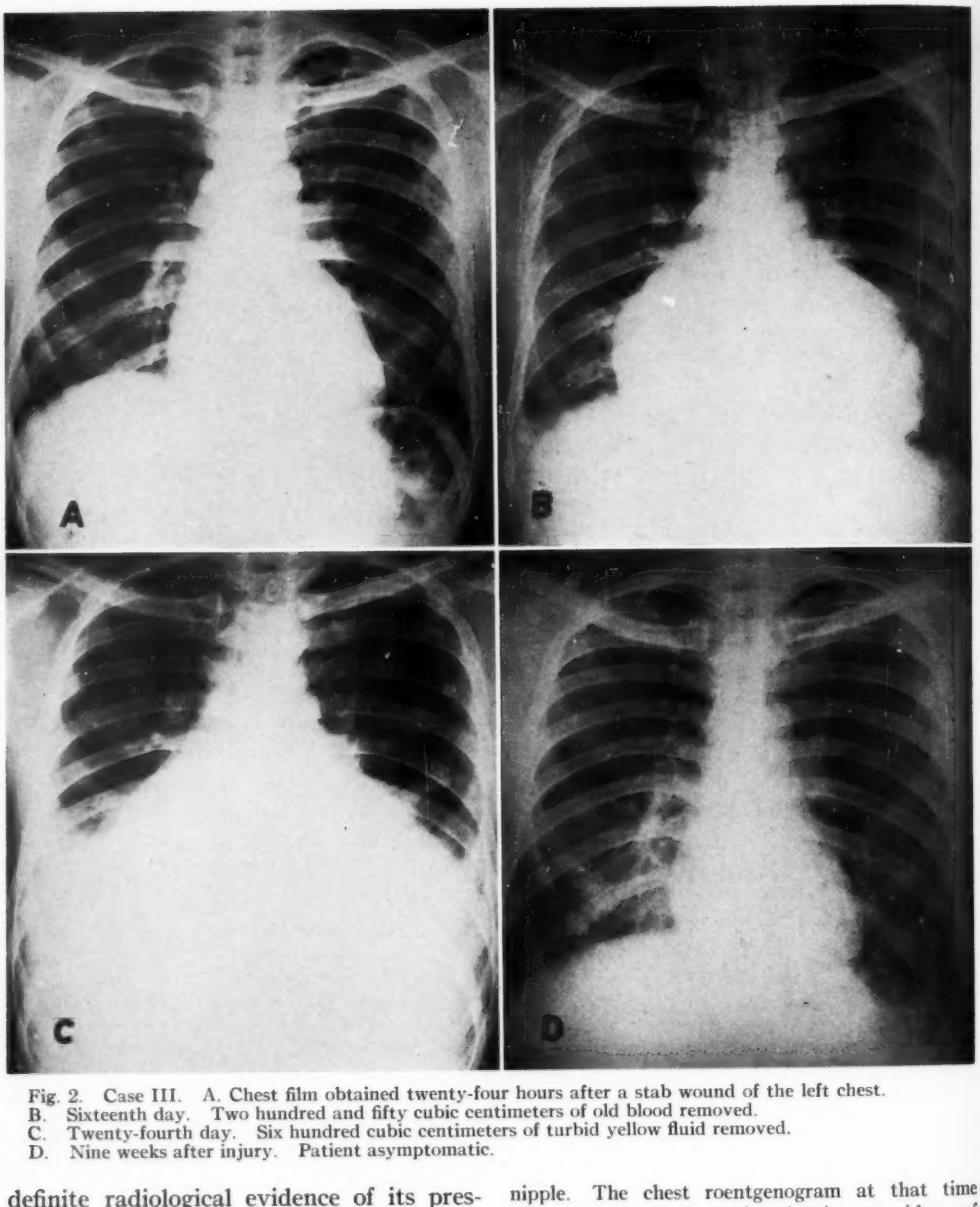

Fig. 2. Case III. A. Chest film obtained twenty-four hours after a stab wound of the left chest.
B. Sixteenth day. Two hundred and fifty cubic centimeters of old blood removed.
C. Twenty-fourth day. Six hundred cubic centimeters of turbid yellow fluid removed.
D. Nine weeks after injury. Patient asymptomatic.

definite radiological evidence of its presence was lacking, as the examination was made in the supine position, as is usual in injuries of this type.

PERICARDIAL WOUNDS

CASE III. A 34-year-old colored male was first seen in the emergency room about twenty-four hours after being stabbed in the left chest through the nipple. The chest roentgenogram at that time (Fig. 2, A) was interpreted as showing no evidence of hemopneumothorax or hemopericardium. The patient was dismissed to be followed in the clinic. Two days later, he started to experience chest pain, especially when he coughed. This was interpreted as a "cold." On the fifth and ninth days further roentgenograms of the chest were taken in the clinic. The fifth-day film was interpreted as showing no change since the previous examination and was not considered diagnostic of definite hemopericardium

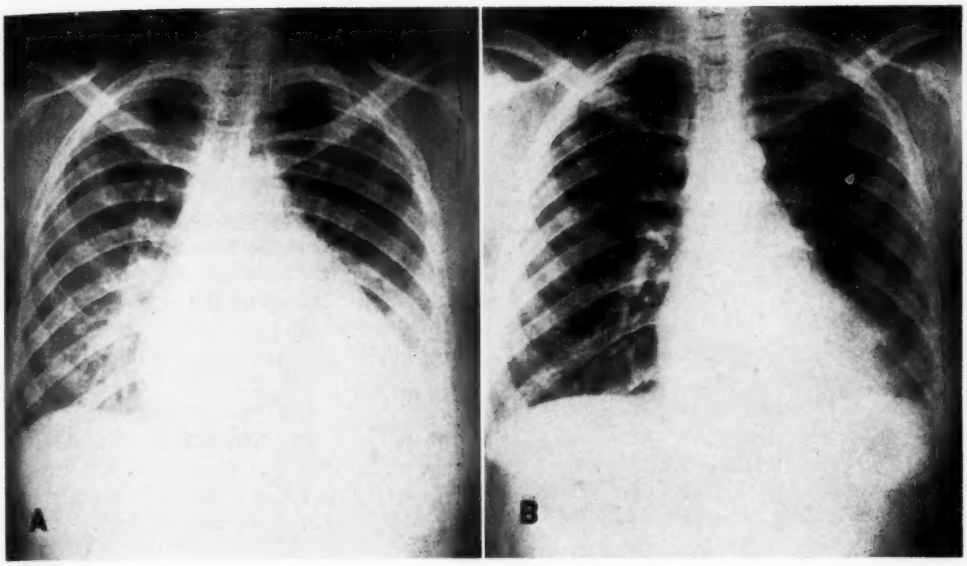

Fig. 3. Case IV. A. Initial film immediately following stab wound of the thorax. Enlargement of cardiac shadow, with straightening of left heart border.
B. Cardiac silhouette eleven weeks later.

During this time, the patient was having progressive chest pain and also complained of paroxysmal nocturnal dyspnea, orthopnea, and exertional dyspnea, being unable to climb stairs. Because of increase in severity of these symptoms, he was admitted to the hospital on the sixteenth day. At this time a chest roentgenogram (Fig. 2, B) showed a notable change in the cardiac silhouette. The blood pressure was 115 mm. Hg systolic, and 90 mm. Hg diastolic; the pulse was paradoxical and the venous pressure 342 mm. of water. Pericardial aspiration yielded 250 c.c. of old blood; on the eighteenth day, 175 c.c. of serosanguineous fluid was obtained, and smaller amounts were withdrawn during the subsequent two days. Figure 2, C demonstrates the appearance of the cardiac silhouette twenty-four days after injury; 600 c.c. of yellow turbid fluid was then removed by thoracentesis of the right pleural cavity and open drainage of the pericardial sac was performed. Cultures of fluid from both sites showed hemolytic *Streptococcus* and *Staphylococcus aureus*. The patient was afebrile from this time on and was dismissed from the clinic thirty-six days after the initial stab wound, with persistent evidence of pericardial and pleural effusion. He was readmitted for evaluation nine weeks after the injury, when no abnormal clinical signs were found. The chest film taken at that time is reproduced in Figure 2, D. The patient was completely well.

CASE IV: A 25-year-old colored female was admitted to the hospital immediately after being stabbed in the third left intercostal space. The heart sounds were found to be distant and there was also evidence of hemothorax on the left. A chest film showed enlargement of the cardiac silhouette with straightening of the left heart border, findings which were considered consistent with a diagnosis of hemopericardium (Fig. 3, A). The pericardial sac was immediately tapped and 85 c.c. of nonclotting blood was aspirated. An hour later, another 80 c.c. was removed. The patient rapidly improved and was dismissed from the hospital six days after admission.

CASE V: A 25-year-old colored male was seen in the emergency room immediately following multiple stab wounds of the chest. There was evidence of hemothorax on the left and the abdomen remained rigid for many hours. The chest film was not considered diagnostic of hemopericardium, although straightening of the left heart border was noted. Surgical exploration revealed no injury to the abdominal organs, but 1,000 c.c. of blood was removed from the left thoracic cavity and 200 c.c. of blood was found in the pericardial sac.

Comment: In Case III, when the initial chest film taken following the stab wound was compared with a roentgenogram taken in a routine examination nine months previously, prominence of the left heart border was apparent. The cardiac silhouette, as a whole, became progressively larger after the injury. The diagnosis of

Fig. 4. Case VII. Pneumopericardium following a stab wound of the chest.

hemopericardium could have been made after nine days, but the change in size of the cardiac silhouette was minimal and the fact that the transverse diameter of the heart can vary 1 cm. or more, depending on whether the exposure is made in systole or diastole, had to be taken into account. A somewhat similar appearance of the cardiac silhouette is seen in minimal enlargement of the myocardium. The position of the diaphragm in the twenty-four hour film (Fig. 2, A) was lower than in the earlier, routine film, making the increase in the cardiac diameter of even greater significance. The first pericardial tap was done on the sixteenth day (Fig. 2, B), when cardiac tamponade was clinically evident.

Nine weeks after injury the cardiac silhouette (Fig. 2, D) was similar to that before injury. This does not, however, preclude persistent fluid.

In Case IV, the initial chest film (Fig. 3, A) demonstrated straightening of the left heart border. With the history of stab wound, the appearance of the cardiac silhouette was interpreted as indicating hemopericardium.

Figure 3, B shows the cardiac silhouette eleven weeks after injury. Ten months later examination suggested that reaccumulation of fluid had occurred, a circumstance which is possible in an asymptomatic patient. Angiocardiography can be employed to obtain positive evidence of reaccumulation and to differentiate it from cardiac enlargement.

In Case V there was difficulty in diagnosing appreciable amounts of fluid in the pericardial sac with confidence. The appearance of the cardiac silhouette in the initial film was not outside the limits of normal, yet 200 c.c. of blood was present in the pericardial sac. When the patient was discharged as well, there was essentially no change in the cardiac silhouette and there was still a possibility that persistent fluid was present.

Simulated Hemopericardium

In cases of hemothorax, blood may become loculated between the mediastinal pleura and the lung.

CASE VI: A 25-year-old colored male suffered a stab wound of the left hemithorax. In the emergency room, he gave indications of shock, but there was no clinical evidence of cardiac tamponade. The initial chest film showed fluid in the left pleural cavity between the lung and the heart. Associated hemopericardium, however, was not excluded.

Comment: The initial chest film in this case showed apparent enlargement of the cardiac silhouette. The left heart border, however, was ill defined, which indicated fluid between the heart and the lung in addition to the typical finding of fluid in the pleural cavity, represented by obliteration of the costophrenic angle. A normal-appearing cardiac silhouette was demonstrated eighteen days following removal of a large amount of blood from the pleural cavity. Although associated hemopericardium could not be excluded in the initial chest film, there was no clinical evidence of this and serial examination did not suggest it.

Pneumopericardium

Penetration of the parietal pericardium in some instances allows air to enter the

pericardial sac. This usually does not cause any symptoms and recovery is uneventful.

CASE VII: A 30-year-old colored male was admitted to the hospital immediately after a stab wound in the second intercostal space just to the left of the sternum. There were no signs of hemopericardium or hemothorax. However, the chest film (Fig. 4) showed pneumopericardium. On the second hospital day, the patient was asymptomatic and was discharged.

Comment: It is noted that the heart in Figure 4 is completely surrounded by air, more obvious on the left, without evidence of a fluid level to indicate associated bleeding into the pericardial sac. Pneumopericardium is occasionally encountered in association with spontaneous pneumomediastinum, or more rarely with pneumothorax, when a congenital defect in the parietal pericardium allows air to pass around the heart from the pleural cavity. In this instance there was no evidence of associated pneumothorax at any time.

LOWER THORACIC WOUNDS

The extent of injury caused by penetrating wounds of the lower thoracic region may not be readily apparent, particularly if the instrument is long and thin, such as an ice pick, a weapon frequently used. Lacerations of the diaphragm, with associated penetration of the liver on the right side, or of the spleen on the left, commonly occur following these injuries.

Initial films of the chest may show little of note apart from pneumothorax. An abdominal roentgenogram should be taken initially, and serial films of the abdomen and chest often yield valuable information.

CASE VIII: A young colored male sustained a wound of the left lower thoracic region. As there was no evidence of hemothorax or pneumothorax, he was discharged. Five weeks later he returned complaining of epigastric pain. A plain film of the abdomen and a gastrointestinal examination were ordered. There was then obvious enlargement of the splenic shadow.

CASE IX: A 51-year-old colored male was admitted to the hospital after being stabbed in the right eighth intercostal space in the anterior axillary line. The chest film was interpreted as showing pneumothorax with an associated penetrating wound of an abdominal viscus. On surgical exploration, the wound was seen to have penetrated the right diaphragm and extended into the liver. Approximately 2,500 c.c. of blood was removed from the peritoneal cavity; there was no evidence of bowel perforation. The patient slowly improved and was dismissed from the hospital after two weeks.

Comment: In Case VIII, the plain film of the abdomen, five weeks after injury, demonstrated a definite change in the size of the splenic shadow, when compared with the initial chest film. The splenic flexure containing gas was seen to be displaced downward by the enlarged spleen, a finding confirmed by barium-enema examination. The barium-filled stomach also showed the characteristic deformity of the greater curvature seen with splenic enlargement. The radiological diagnosis of subcapsular hemorrhage of the spleen was confirmed at operation, when splenectomy was performed.

In Case IX, it appeared doubtful clinically that laceration of the liver was present with bleeding into the peritoneal cavity. There was, however, free gas beneath the diaphragm, which was incorrectly interpreted as representing associated perforation of the intestinal tract. It was noted that pneumothorax was also present; air had apparently passed from the pleural cavity through the laceration in the diaphragm to give the appearance of free gas in the peritoneal cavity.

DISCUSSION

It is evident that in cases of stab wounds of the supraclavicular area, hemorrhage into the mediastinum can be established by x-ray examination of the chest; the gravity of the patient's injury will become apparent and prompt surgical treatment will be instituted.

The amount of fluid in the pericardial sac necessary to give symptoms and signs of cardiac tamponade depends on the rapidity of filling of the pericardial sac.

For example, in diseases such as chronic pericarditis and myxedema, where there is slow accumulation of fluid, the cardiac silhouette may be obviously enlarged, though the patient may not show evidence of the effect of tamponade. The sudden effusion of "200–250 gm. (7–10 oz.) of liquid as in hemorrhage into the pericardium is sufficient to arrest the heart's action by compression, while in chronic distention the fibrinous layer will gradually give way and 500–2,000 gm. (17–60 oz.) of fluid may collect in the sac without causing death" (Ballance).

It is estimated that 200 c.c. of fluid may be present in the pericardial sac without altering the contour of the cardiac silhouette appreciably (Levene). A roentgen study of the chest may, therefore, not be diagnostic, particularly if it is a portable supine examination. Straightening of the left heart border has been noted in cases of acute hemopericardium. Although this finding in itself cannot be considered pathognomonic of blood in the pericardial sac, the example of pneumopericardium (Case VII) demonstrates how distention of the pericardial space can cause straightening of the left heart border.

It is apparent that serial films of the chest are indicated in pericardial injury to detect recurrence of bleeding and delayed exudative pericardial effusion. Angiocardiography may be employed when necessary.

The present consensus is that hemopericardium is best managed by pericardial aspiration initially rather than by open operation, as the mortality for the latter has been found to be quite high (Cooley). The decision whether or not to aspirate the pericardial space rests with a clinical diagnosis of developing tamponade, *i.e.*, evidence of shock, cyanosis, dyspnea, paradoxical pulse. Removal of a small quantity of blood may be sufficient to cause dramatic improvement in the condition of such patients. It would seem rational, however, that an opening in the parietal pericardium should be made, if there is evidence of persistent fluid, to permit drainage into the pleural space. This would avoid delayed exudative pericarditis and the possibility of adhesive pericarditis as a late complication. It is now considered standard practice in cardiac surgery to leave such an opening in the pericardium.

Soloff described reactivation of rheumatic fever following mitral commissurotomy, but such findings can be produced by closure of the parietal pericardium after heart surgery. Delayed exudative pericarditis in these circumstances was attributed by Bailey to irritation by blood retained in the sac and it was emphasized by Ehrenhaft and Taber that adhesive pericarditis in many instances may result from neglect of hemopericardium.

In penetrating wounds of the lower thoracic region, follow-up roentgenograms of the abdomen are of considerable value in determining whether or not there is occult injury to the spleen.

SUMMARY

The radiological aspects of supraclavicular, pericardial, and lower thoracic stab wounds are discussed.

Unsuspected hemomediastinum complicating a supraclavicular stab wound shows a characteristic appearance of widening of the superior mediastinum.

Initial anteroposterior supine projections of the chest in suspected hemopericardium are difficult to interpret accurately but many cases of proved hemopericardium show straightening of the left heart border. Rapid accumulation of a relatively small amount of blood in the pericardial sac is sufficient to cause severe symptoms of acute cardiac tamponade. This can be diagnosed accurately on clinical grounds when the radiological findings are equivocal. Serial films of the chest are necessary to detect reaccumulation of fluid and delayed exudative pericardial effusion. In follow-up films, the cardiac silhouette may appear within normal limits even in the presence of appreciable amounts of fluid in the pericardial sac; angiocardiog-

raphy is necessary to exclude persistent fluid in these instances.

Although aspiration, rather than open operation, is considered the treatment of choice initially, it would seem rational that an opening in the parietal pericardium should be made as a secondary procedure if there is established evidence of persistent fluid. This would permit drainage into the pleural space and avoid delayed exudative pericarditis and adhesive pericarditis as a possible late complication.

In penetrating wounds of the left lower thorax, occult injury to the spleen is readily diagnosed by change in contour of the splenic shadow in follow-up films of the chest and abdomen.

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1917 Ashland
Houston 8, Texas

SUMMARIO IN INTERLINGUA

Aspectos Radiologic de Vulneres Puncturate del Thorace

Le signification de roentgenogrammas initial post vulneration puncturante del thorace es discutite con referentias a tres areas anatomic. Istos es le area supraclavicular e mediastinal, le area pericardial, e le area infero-thoracic.

In le caso de vulneres puncturate del area supraclavicular, allargamento del umbra mediastinal pote indicar hemorrhagia a in le mediastino. In tal casos il es usual que le pression a in le mediastino cresce, que le pleura mediastinal es rupturate, e que il occurre le disveloppamento de un hemothorace associate.

In casos de suspicion de hemopericardio, initial projectiones anteroposterior thoracic, con le patiente in decubito supin, es difficile a interpretar accuratemente, sed multe casos confirmate de hemopericardio exhibi un rectation del margine sinistre del corde. Le rapide accumulation de mesmo un micre quantitate de sanguine in le sacco pericardial es significative como causa de sever symptomas de acute tamponage cardiac. Roentgenogrammas serial del thorace es necessari pro deteger le reaccumulation de liquido e tardive exsudative effusion pericardial. Ben que aspiration plus tosto que operation aperte es considerate como le tractamento de election initial in casos de hemopericardio, il pare plausibile que un apertura in le pericardio parietal debe esser effectuate como mesura secundari quando il ha prova definitive de liquido persistente. Un tal apertura permitte le drainage a in le spatio pleural e evita le disveloppamento de tardive pericarditis exsudative e de pericarditis adhesive como complication subsequente.

In casos de vulneration infero-thoracic, lacerationes del diaphragma con le associate penetration del hepate al latere dextere o del splen al latere sinistre es occurrentias commun.

Casos illustrative es reportate.

Recognition of Infrapulmonary Pleural Effusion[1]

JAMES A. PETERSEN, M.D.

PLEURAL effusion of the infrapulmonary type, though common, may not be recognized by conventional radiographic studies of the chest until the fluid has increased to considerable proportions. In its subpulmonary, basal, or diaphragmatic position the fluid forms as a layer in the pleural space between the concavity of the undersurface of the lung and the convexity of the dome of the diaphragm. In this position it is often overlooked because it masquerades as an elevated diaphragmatic leaf. The films are frequently interpreted as indicating elevation of the diaphragm with a small amount of fluid in the costophrenic gutter, whereas in fact the diaphragm lies at a normal or lower than normal level, and the quantity of fluid present is large. An observer who is suspicious of every apparent elevation of the diaphragm and cognizant of the appearance and diagnostic meaning of minimal amounts of fluid will discover that infrapulmonary effusion, although generally considered rare, is rather unrecognized than unusual.

The cases presented in this paper were drawn from a larger group representing the general practice of radiology. Twenty-five[2] were selected for study because of excellence of film quality or because particular features were demonstrated or special diagnostic procedures had been performed. Ten cases were associated with heart disease, 7 with malignant neoplasm, 4 with hypoproteinemia (nephrosis, cirrhosis), and 4 with inflammatory pulmonary or pleural disease. In 5 patients the process was bilateral; of the 20 with unilateral involvement, the effusion was on the right side in 14 and on the left in 6.

Only 1 of the group was followed to autopsy. In this instance, films taken before death showed bilateral infrapulmonary effusions. At autopsy, although the costal pleura was studded with tumor nodules, the visceral pleura was normal and there were no interpleural adhesions (Fig. 7).

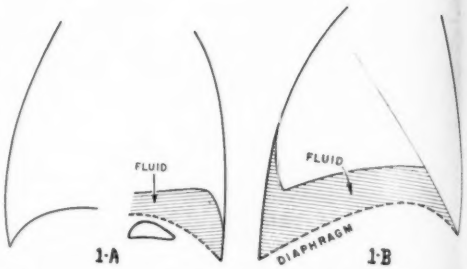


Fig. 1. Schematic representation of infrapulmonary effusion as demonstrated on postero-anterior and lateral film.

ROENTGEN MANIFESTATIONS OF INFRAPULMONARY EFFUSIONS

Although the true nature of the infrapulmonary effusion will declare itself when studied by particular technics, its prompt recognition from routine chest films is of value. A number of characteristic signs may establish the diagnosis. From this selected group of cases the roentgen manifestations of the disease processes both on conventional examinations and by special technics have been determined, and the findings are presented.

Typically an infrapulmonary effusion presents itself in the *postero-anterior upright projection* as an apparently elevated leaf of the diaphragm, with a contour similar to a diaphragmatic shadow and just as sharply outlined. Hessén (11) described a characteristic form of this pseudo-diaphragmatic shadow (not always present) which suggests effusion. There is a gradual inclination upward and laterally

[1] From the Department of Radiology, Massachusetts General Hospital, Boston, Mass. Accepted for publication in Feburary 1959.

[2] In addition to those from the Massachusetts General Hospital, cases were also derived from the Symmes Hospital, Arlington, Mass., the Somerville Hospital, Somerville, Mass., and the Medical Division, Oak Ridge Institute of Nuclear Studies, Oak Ridge, Tenn., under contract with the Atomic Energy Commission.

Fig. 2. Detail of the anterior portion of the upper margin of the fluid seen on lateral projection. The straight segment of the fluid margin is continuous with the major fissure (arrows).

from the cardiac shadow, with a rather abrupt drop near the costal margin to form a sharp gutter similar to a normal costophrenic angle (Fig. 1, A). With large quantities of fluid (more than a liter) the central upper contour may maintain its pseudo-diaphragmatic shape but effusion will become more evident in the lateral gutter, along the mediastinum, and in the fissures. On the left side, in the absence of pleural fluid, the top of the gastric air bubble will lie at a distance of a few millimeters to 1 cm. from the diaphragm. Increase of the space between lung and gastric fundus should arouse suspicion of infrapulmonary fluid and may indicate the thickness of fluid layer beneath the lung (Fig. 3). Occasionally an enlarged spleen interposed between diaphragm and gastric fundus or a tumor in the fundus of the stomach may confuse the picture, especially if the gas bubble is small. Nearly all cases, if examined carefully, will show at least a small quantity of fluid in the lateral gutter. Effusion extending into the major fissure may produce a faint ill defined density just above the sharp pseudo-diaphragmatic shadow.

In the *lateral upright* as well as in the *postero-anterior projection*, infrapulmonary effusion may show an upper contour like that of the diaphragm. More often, however, only the midportion of the upper

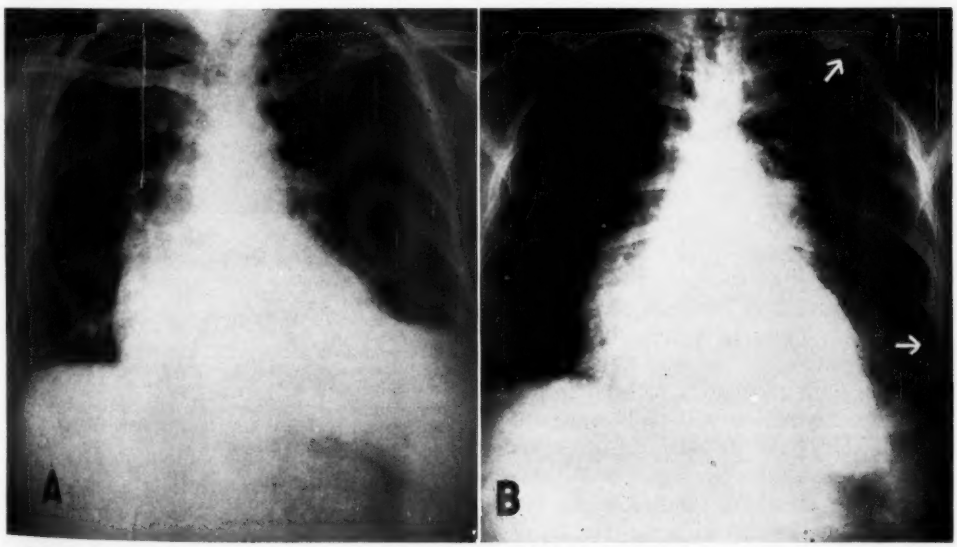


Fig. 3. Case RF. A. Note the apparent elevation of the left leaf of the diaphragm and the separation of lung and gastric fundus. B. Supine film shows only a slight differential of density between the two pleural spaces, but a thin rim of fluid can be seen about the apex and lateral margins of the lung.
Following the exposure of these films, 950 c.c. of serous fluid was removed from the left pleural space.

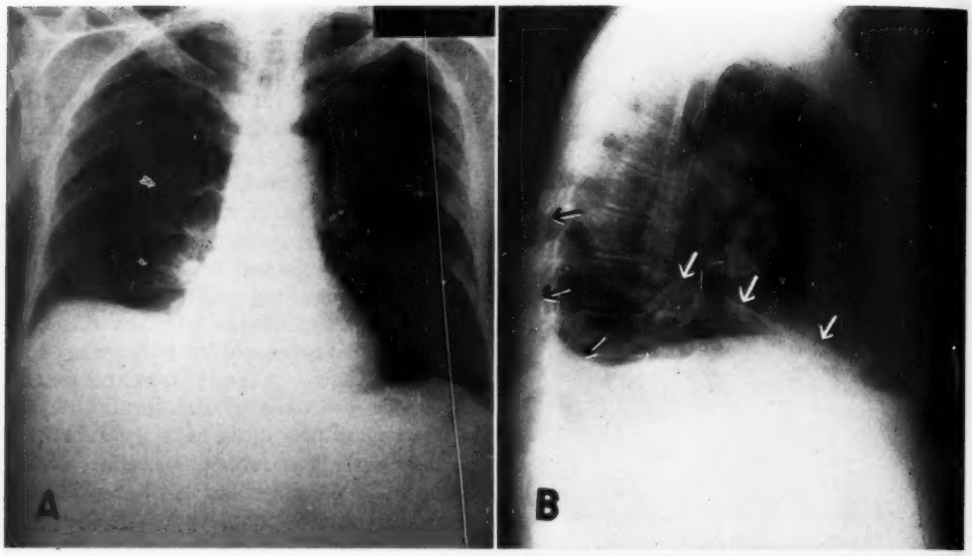
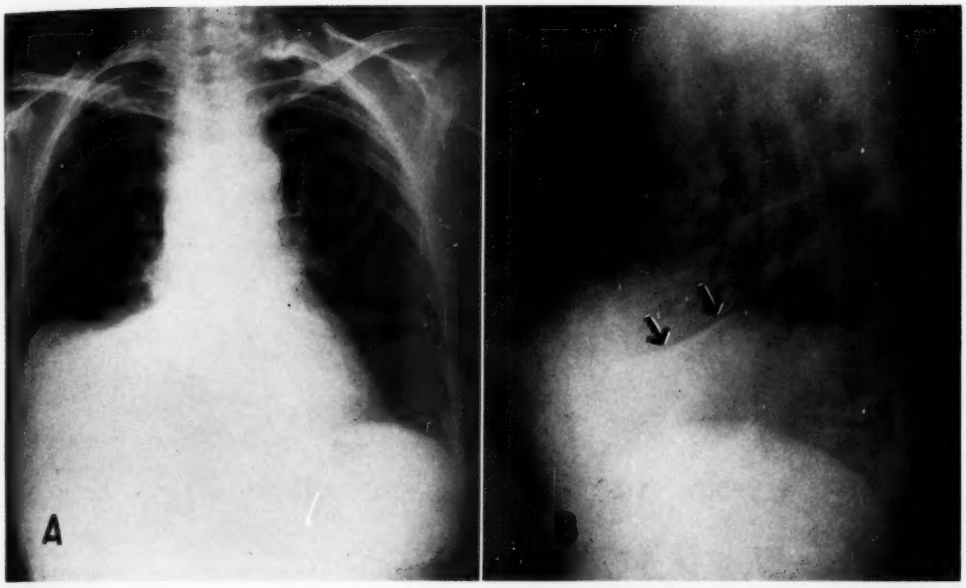


Fig. 4. Case GP. A. The diaphragm-like shadow on the right has its highest point close to the lateral margin. The gutter is quite sharp. B. Lateral upright film shows that the interface of the right middle lobe with the fluid forms a straight contour continuous with the major fissure (white arrows). Fluid can also be recognized in the posterior gutter tapering superiorly as a thin wedge of density (black arrows). C. Decubitus film, made with the patient lying on his right side and with the central ray horizontal, shows fluid filling the dependent lateral thoracic space and dissecting into the major and minor fissures.

margin of the fluid is rounded and the posterior gutter is filled (Fig. 1, B). Experience has shown that, without exception, fluid can be demonstrated posteriorly as a thin wedge of density tapering upward, separating the visceral and parietal pleura. For reasons not well understood, an infrapulmonary effusion appears to reduce the volume of the lower lobe of the normal lung while the remaining lobe or lobes seem to be unchanged in size and position. This produces a rather characteristic configuration on the lateral film where the convex upper margin of the fluid meets the major fissure, forming a straight component of the pseudo-diaphragmatic shadow anteriorly (Figs. 1,B, 2, and 4). In many cases widening of the linear shadow of the major fissure above the bulk of the effusion is shown. This is produced by fluid extending into the fissure. A film exposed with the patient slightly rotated from the true lateral position will yield more information than one in which the posterior costophrenic angles overlap.

In *lateral decubitus* studies made with a horizontal beam and with the patient lying on the affected side, the amount of hidden effusion will be graphically portrayed, its mobility will be indicated, and the true position of the diaphragm will be shown (Fig. 4). Small amounts of fluid may be better demonstrated with the patient's shoulders slightly below the level of the hips (Hessén). The horizontal central



ray is directed to the dependent lateral chest wall.

Supine studies also show the true level of the diaphragm and mobility of the fluid and, compared with the normal side, a uniform haziness overshadowing the affected lung. With only a small effusion, the differential in density may be difficult to detect; with larger quantities this is readily apparent and, in addition, a thin shell of fluid about the lateral margins and apex of the lung is visible (Figs. 3 and 5).

Pneumoperitoneum with upright films sharply delineates the true level of the diaphragm and graphically indicates in both the postero-anterior and lateral projections the exact position of the fluid, as well as its formation in a curved layer between lung and diaphragm (Fig. 7).

Fluoroscopy with the patient upright ordinarily shows that diaphragmatic mobility is not impaired and the upper border of the fluid maintains its contour and transmitted mobility. With suspended respiration, the upper shadow of the fluid is seen to "shimmer" or undulate, due to agitation by normal cardiac motion. With deep inspiration, the infrapulmonary effusion tends to maintain its position, with

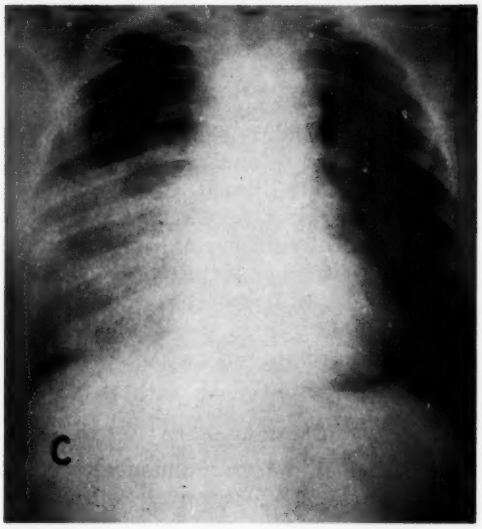


Fig. 5. Case HD. A. Postero-anterior view. Note the apparent elevation of the right leaf of the diaphragm. B. The lateral projection demonstrates the straight contour of the anterior margin of the fluid. C. The supine film shows the true level of the diaphragm. The relatively increased density of the right hemithorax as well as fluid along the lateral chest wall is quite evident.

sharp "costophrenic" angles, but on forced expiration the lung loses some of its elasticity and the intrathoracic space is reduced in volume, thereby causing much of the

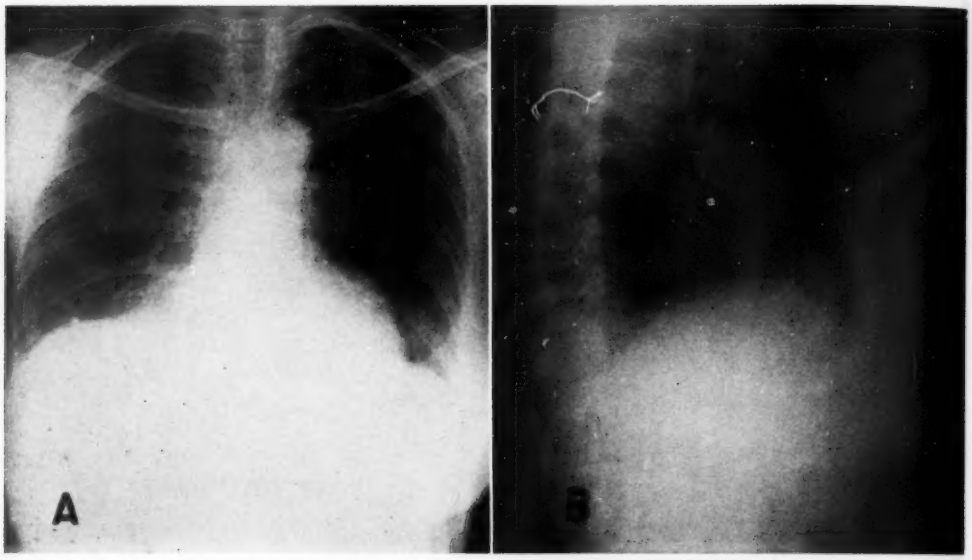


Fig. 6. Case RS. A. Postero-anterior upright projection: The diaphragm leaves appear to lie at normal levels. B. Lateral upright view: Note the elliptical shadow of fluid obliterating the more posterior costophrenic angle. The straight segment of the fluid margin anteriorly is not sharply defined, but the middle lobe extends unusually low as compared with the lower lobe. C. Lateral decubitus film reveals a surprising quantity of free pleural fluid.

fluid to spill out into the gutters and assume the more usual appearance of pleural effusion.

During fluoroscopy, lateral tilting with the patient standing shows the ease with which the fluid will spill from its position beneath the lung (Fig. 8). The prominent role of gravity in determining the localization of pleural fluid is emphasized by this maneuver. Tilting of the patient laterally or backward will also cause the vertical wedge of fluid to increase in thickness and produce detectable changes in physical signs.

CLINICAL CORRELATION

Fluid held in the infrapulmonary position will produce a percussion note similar to that of liver; the upper margin of the effusion is as sharply defined as the diaphragm, whose mobility is transmitted to the fluid layer. Clinical examination of the chest may therefore produce only signs of an elevated but mobile diaphragm leaf when the patient is examined in the upright position. The thin wedge of fluid that extends superiorly from the posterior gutter separating parietal pleura and lung may or may not be detectable by physical signs. However, excessive upward excursion of the "diaphragmatic dullness" with forced expiration may provide a clue that free fluid is present. It has been observed that, while inspiration increases the integrity of the infrapulmonary effusion, forced expira-

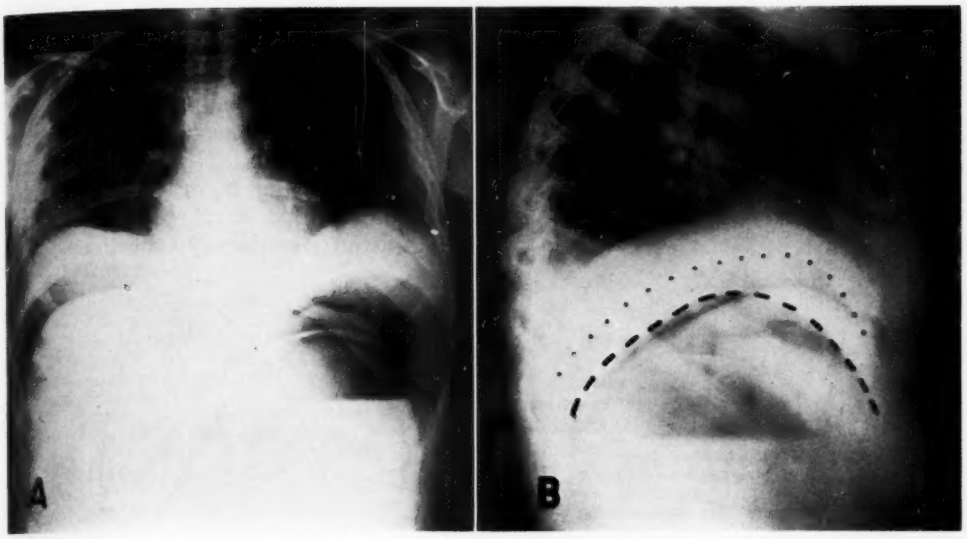


Fig. 7. Case SY. Pneumoperitoneum outlines the true level of the diaphragm and demonstrates the curved layer of fluid between it and the lung. On the lateral view (B) the diaphragm shadows are indicated by broken lines. The upper margins of the fluid collections are nearly superimposed. (The density seen along the lateral aspect of the right thorax on the postero-anterior view was shown at autopsy to be tumor tissue.)

tion causes spilling out into the gutters (see above).

Thoracentesis of an effusion chiefly confined to the infrapulmonary position is difficult because relatively little of the costal pleura is exposed to the fluid. This is especially true when the procedure is carried out with the patient seated and leaning forward with his arms resting on a bed or the back of a chair. With the patient semirecumbent and the needle placed in the posterior axillary line, thoracentesis is most successful.

DISCUSSION

Recognition of infrapulmonary effusion on the left side is usually not difficult because of the unusual separation of the lung and the gas bubble of the stomach. On the right side the most valuable criterion in recognition of fluid beneath the lung on conventional films is the identification, on the lateral view, of the "straight-line" contour of the anterior portion of the pseudo-diaphragmatic shadow. This image is produced by the fluid adjacent to the posterior surface of the middle lobe. (The same appearance may be seen on the left side posterior to the lingula.) It is sharply outlined on the lateral film only when the central ray of the x-ray beam approximates the plane of the major fissure. When this does not occur, the process may be recognized by the unusual inferior extension of the middle lobe relative to the lower lobe.

The characteristic curvature of the diaphragm-like shadow seen on the postero-anterior projection and described by Hessén is an excellent sign of infrapulmonary effusion, but unfortunately it is not always present (less than half the cases of this series).

Demonstration by fluoroscopy, or on the lateral film, of fluid spilling out into the lateral or posterior gutter is also a valuable finding in detection of infrapulmonary effusion. This spilling of fluid from beneath the lung is encouraged by the usual positioning of the patient for a lateral view, with upstretched arms and extension of the spine, increasing the dependency of the posterior gutter. All characteristics of infrapulmonary effusion are, of course, lost when the patient is examined in some position other than the upright.

Fig. 8. Case LW. Spot films made during fluoroscopic examination with the patient standing. A. Exposure made with patient erect. Note separation of lung and stomach bubble. B. Exposure made with the patient leaning to his left. Note the wedge of fluid along the lateral pleura and the persistence of a sharp gutter.

Suspicion of every elevated diaphragm leaf will be rewarding in leading to the diagnosis of infrapulmonary effusion. Even this may not be reliable, however, despite the presence of a considerable quantity of fluid, as shown by the case illustrated in Figure 6.

A combination of physical and physiological forces has been reported as being operative in localizing fluid in this peculiar position. Among the authors who have recorded their observations there has been no factual analysis of these factors nor has there been a common opinion of the total force. In general, it is agreed that gravity is probably the main factor. Some investigators have implicated elasticity of the lung, basal pulmonary atelectasis, interpleural cohesion, pleural adhesions, and specific gravity and surface tension of the fluid as well. Hessén, who has studied pleural effusions most thoroughly, including human necropsy and animal experiments, concluded that the infrapulmonary position is the normal result when fluid accumulates in a pleural space that is free of adhesions and the lung is healthy. This concept has been supported by Barry (14) and Friedman (12) and conforms to the observations in the cases reviewed for this study.

Hessén, utilizing a horizontal x-ray beam, also demonstrated minute quantities of fluid in apparently healthy individuals in the lateral decubitus position. Several authors, including Hessén, have been of the opinion that most pleural effusions begin as infrapulmonary collections. The

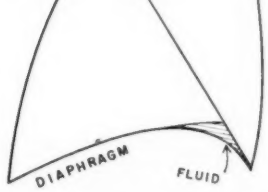


Fig. 9. Configuration of minimal effusion.

straight line contour of the anterior diaphragm shadow described on the lateral projection in the presence of infrapulmonary effusion may also be seen in cases where other signs of pleural fluid are absent. Careful lateral decubitus studies of these cases may reveal a layer of only 2 or 3 mm. of fluid. It is suggested that the junction of the major fissure with the diaphragm may commonly be the site of small amounts of pleural fluid (which are possibly physiological) and that the straight contour described is a sign of minimal pleural effusion not otherwise recognized on routine roentgenograms (Fig. 9).

SUMMARY

The roentgen manifestations of infrapulmonary pleural effusions have been outlined, with emphasis on the points observed in routine film studies.

More study of the physical, chemical, physiological, and pathological forces that influence the position of pleural fluid is needed.

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Massachusetts General Hospital
Boston, Mass.

SUMMARIO IN INTERLINGUA

Recognition de Effusion Pleural Infrapulmonar

Vinti-cinque casos de effusion infrapulmonar esseva studiate con referentia particular a lor recognition in studios roentgenologic routinari.

Le diagnose de effusion infrapulmonar al latere sinistre non es difficile in le majoritate del casos a causa del presentia de un separation inusual del pulmon e del bulla de gas del stomacho. Al latere dextere le plus utile criterio in le detection de liquido infra le pulmon in roentgenogrammas conventional es le identification, in projectiones lateral, del contorno "rectilinee" del portion anterior del umbra pseudodiaphragmatic, que es le effecto del liquido adjacente al superficie posterior del lobo central.

Le curvatura characteristic in le umbra diaphragmoide visibile in le projection postero-anterior es un signo excellente, sed in le presente serie illo esseva presente in minus que un medietate del casos.

Le demonstration, per fluoroscopia o in projectiones lateral, de liquido exiente a in le guttiera lateral o posterior es etiam de valor in le detection de effusion infrapulmonar.

In le effortio de deteger casos occulte de iste condition, il vale le pena suspectar omne elevate lobo del diaphragma.

Chest Roentgenographic Changes in Systemic Lupus Erythematosus[1]

JAMES G. BULGRIN, M.D., EDMUND L. DUBOIS, M.D., and GEORGE JACOBSON, M.D.

DURING the past eight years, 275 patients with systemic lupus erythematosus have been under the clinical supervision of one of the authors (E. L. D.). Roentgenograms of the chest were reviewed in 207 of these. In view of the variability of the reported incidence and nature of the roentgenographic changes in this disease, it was thought that a presentation of the findings and a comparison with those of others would aid in evaluation of one facet of this complex entity.

CLINICAL FEATURES

Systemic lupus erythematosus is a chronic disease occurring predominantly in females and subject to spontaneous exacerbations and remissions. In one study, remissions were seen in almost 40 per cent of cases (1). Although occasionally a single organ system bears the brunt of this disease, the manifestations are protean and characteristically many organ systems are affected. The extent of involvement of any site and the number of organs involved are equally unpredictable. The outline below classifies the clinical manifestations and demonstrates their multiplicity.

Clinical Picture of Systemic Lupus Erythematosus

1. Signs of catabolism: fever, weight loss, emaciation.
2. Connective-tissue lesions: pleurisy, pericarditis, rheumatoid arthritis.
3. Vascular lesions: skin, ocular fundi, kidney, central nervous system, gastrointestinal tract, adenopathy, splenomegaly, Raynaud's phenomenon.
4. Depression of peripheral blood elements: normocytic anemia, leukopenia, thrombocytopenia, circulating anticoagulant.

TABLE I: METHOD OF DIAGNOSIS

	Number	Per Cent
Positive L. E. cell test	145	70.0
Biopsy	25	12.1
Clinical findings only	37	17.9
Autopsy*	24	11.6

* Even though the diagnosis was confirmed by autopsy, the criteria prior to autopsy are included under the appropriate category.

The first 62 cases of the present series have been reported previously by one of the authors (2), and succeeding cases have shown no significant change in pattern or course. Of the many symptoms listed above, arthritis, cutaneous eruptions, pleurisy, and cardiac involvement are the most frequent. At the onset of the disease and with only one organ system affected, diagnosis is often impossible. This would apply when a patient exhibits atypical rheumatoid arthritis. If, however, unusual skin lesions and renal involvement develop, systemic lupus is very likely. Multiple organ involvement need not be concurrent. A patient may have healed discoid skin lesions and years later develop pleuropericarditis with or without a cutaneous relapse. The extent to which the L. E. cell test and skin biopsy contribute to diagnosis is shown in Table I.

REVIEW OF THE LITERATURE WITH RESPECT TO PLEURAL, PULMONARY, AND CARDIAC CHANGES

Before any extensive reviews of radiologic findings in the chest had been reported, Rakov and Taylor (3) in 1942 and Foldes (4) in 1946 focused attention upon pulmonary changes by reporting single cases of long standing consolidation with peculiar histopathologic features consisting of vascular involvement and disappearance or hyalinization of alveoli. This was called atelectasizing pneumonia.

[1] From the Departments of Radiology (J. G. B. and G. J.) and Internal Medicine (E. L. D.), University of Southern California School of Medicine and the Los Angeles County Hospital. Accepted in February 1959.

Sante and Wyatt (5) in 1951 stated that, in their experience, involvement of the lung proper was very uncommon except in the terminal stages of the disease.

In 1953 and 1954 2 reports appeared which contradicted Sante's impression. Israel (6) thought that nonspecific pneumonia was frequent throughout the course of the disease as well as being common as a terminal event. Garland and Sisson (7) encountered pulmonary changes in one-third of their cases and also found frequent pleural and cardiac abnormalities. Combined organ involvement was quite variable. Table II summarizes the findings in these and later series and compares them to the group reported here.

The largest series of cases of systemic lupus erythematosus previously published is that of Harvey, Shulman *et al.* (8) from the Johns Hopkins Hospital. Gould and Daves (9), of the same institution, reviewed the roentgenograms of virtually the same material. Pleural changes were most frequent. Effusions were small, residual thickening the rule, and bilateral involvement quite frequent. Cardiac enlargement was not usually due to pericardial effusion alone, but to variable involvement of pericardium, endocardium, and myocardium. With few exceptions, pulmonary changes were ascribed to pneumonitis. Roentgenologically the appearance was variable and nonspecific. Harvey, Shulman *et al.*, on the basis of combined clinical, radiological, and pathologic data, believed that pulmonary infiltration specific for the disease existed in almost half of the patients showing involvement of the lungs.

Moersch, Purnell, and Good (10), from the clinical and radiologic standpoints, and Purnell, Baggenstoss, and Olsen (11), from a pathologic standpoint, reviewed a series of cases coming to autopsy at the Mayo Clinic. This group found no radiologic or pathologic evidence of pulmonary infiltration specific for systemic lupus erythematosus. The most interesting feature of the combined studies of this material was the demonstration of the frequency of terminal changes which were not reflected in the roentgenologic survey. Whereas only 12 patients showed pneumonia on films, 41 were found to have bronchopneumonia at autopsy; 10 pleural effusions demonstrated roentgenologically contrasted with 36 at autopsy, and the 3 instances of pulmonary edema demonstrated antemortem were multiplied 10 times in the postmortem tabulations.

ROENTGEN FINDINGS

The roentgen findings are set forth in Table III. Since duration of the disease might well be an important factor in frequency of roentgenographic changes, that relationship is presented in Table IV.

Negative for Any Abnormality: The 96 cases showing no abnormality on one or more chest roentgenograms were by no means confined to the earlier chronological stages of the disease. A considerable number received serial examinations over periods of several years. Eight patients of this group came to autopsy and there was no intrathoracic involvement except for strictly terminal phenomena such as pulmonary edema or bronchopneumonia.

Pleural Changes: Pleural changes occurred as an isolated abnormality as well as in combination with cardiac or pulmonary lesions. There was no regularity as to combined organ involvement. Effusions were generally small and in almost one-half the cases bilateral. With clearing of the effusion there was usually minimal residual pleural thickening. Rapid and unpredictable exacerbation or regression of effusions was far more frequent in patients who had combinations of pleural, cardiac, and/or pulmonary involvement than in those with pleural involvement alone. In 2 autopsied cases no intrathoracic abnormality was encountered other than pleural effusion and/or thickening.

Cardiac Changes: Abnormal cardiac changes consisted of nondistinctive enlargement of the heart, usually minimal to moderate in degree. Isolated cardiac involvement was almost as frequent as iso-

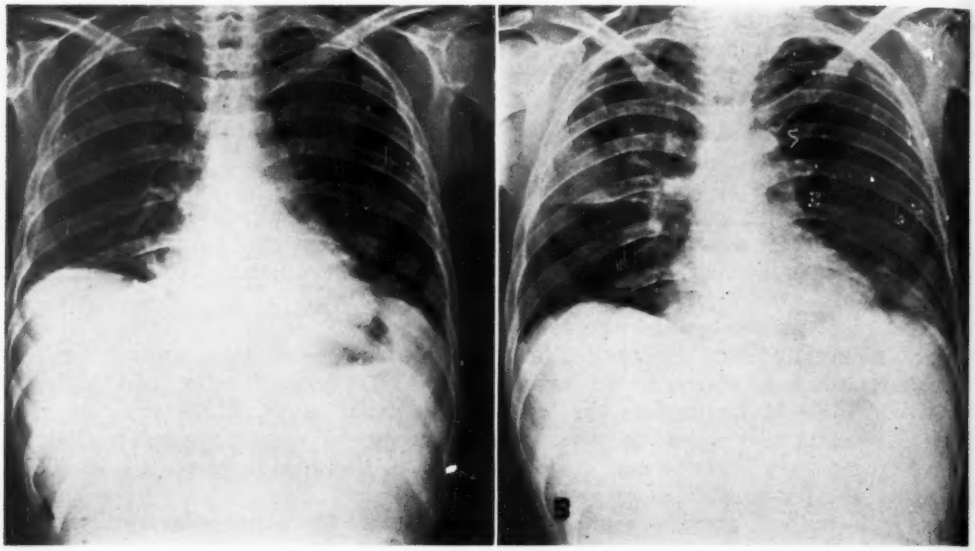


Fig. 1. Case I. A. Infiltration in right upper and left lower lobes, nonspecific in appearance.
B. The infiltration seen in Fig. 1, A, particularly in the right upper lobe, has over a period of months shown progression. There is persistence, but less marked change, in the left lower lobe infiltrate.

lated pleural disease. There was no regularity of combined pleural and/or pulmonary involvement. As was true of pleural effusions, rapid changes in heart size were more frequent where cardiac disease was combined with other intrathoracic abnormality than when cardiac enlargement was an isolated finding. Two autopsied cases showed no chest lesions except for heart disease. With 3 exceptions, where pericardial effusion alone accounted for the enlarged heart, multiple and inseparable causes for cardiomegaly were present. Not only pericardial thickening or adhesions, endocarditis, and myocardial involvement, but hypertension, renal disease, and anemia were frequently contributory.

Pulmonary Changes: Incidental infiltration not related to systemic lupus erythematosus in any manner included tuberculosis in 3 instances, silicosis in 1, and in another lung abscesses and purulent pericarditis.

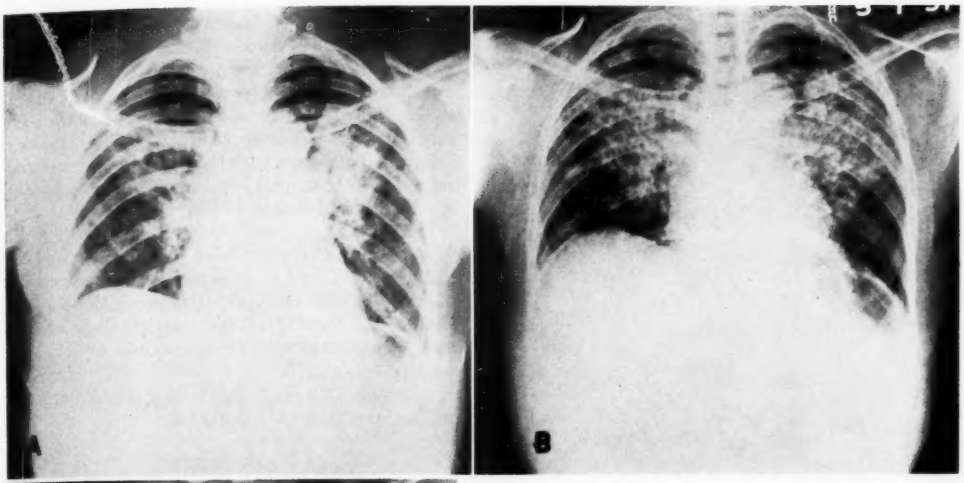
Of the 5 cases of pulmonary edema, 2 were terminal, 1 responded to therapy and was unassociated with other pulmonary change. The other 2 responded to therapy upon one occasion, and each showed, on another occasion, rapidly resolving pneumonia.

The infiltrations thought to represent pneumonia which resolved promptly, whether occurring as a single event or recurrent episodes, had an entirely nonspecific appearance. There was 1 case of extensive and rapidly progressive bronchopneumonia which contributed to the patient's death. It was nonspecific both radiologically and pathologically.

Two patients, each on a single examination, showed nonspecific localized infiltration of unknown duration which had an appearance indistinguishable from infarct, segmental atelectasis, or nonspecific fibrosis. These patients were lost to follow-up.

The remaining three cases are those with the most interesting pulmonary lesions roentgenologically.

CASE I: M. R., a 22-year-old Mexican female, had arthritis for five years, a butterfly facial eruption for one year, and convulsions and other central nervous system manifestations for slightly less than a year. The L. E. cell test was positive. For a month or two before demise, respiratory symptoms and continuous fever were prominent. Roentgenologically (Fig. 1)



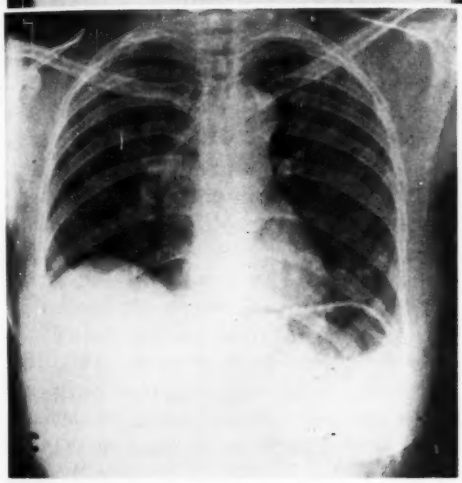


Fig. 2. Case II. A. Extensive bilateral infiltration having the distribution of pulmonary edema.

B. Progression of the infiltration seen in Fig. 2, A. Maximal involvement during the patient's illness is demonstrated here.

C. Gradual regression has occurred over a period of time. This film shows maximal improvement of the extensive infiltration seen in Fig. 2, B.

there was extensive infiltration in the right upper lobe, with less extensive and more patchy disease in the left lower lobe. The involvement persisted over a four-month period and showed progression, especially in the right upper lobe. Pleural and other changes were minimal.

At autopsy, in addition to pleural and pericardial adhesions, extensive pulmonary infiltration was present, corresponding grossly to that seen in the chest roentgenograms. Sections of the heavily infiltrated right upper lobe showed many alveoli filled with protein exudate, numerous areas of round cell and polymorphonuclear infiltration, and thickening of some septa with round-cell infiltration. Many vessels showed great thickening of the walls, with wavy strands of collagenous fibrous material. There were areas of atelectasis and fibrosis.

CASE II: A. C., a 40-year-old Negro female, had noticed swelling of her right knee during pregnancy in 1938. One year later arthritic symptoms developed in the left wrist, and two years later in both wrists. In March 1957 additional symptoms of anorexia, fatigability, and dyspnea upon climbing one flight of stairs appeared. By April 1957 dyspnea was pronounced and a dry, nonproductive cough was present. At this time the vital capacity was 46 per cent of normal. The blood pressure has always been normal. On May 2, 1957, the first positive L. E. cell test was obtained. Steroid therapy was begun eight days later.

A chest roentgenogram on April 2, 1957 (Fig. 2, A) showed extensive bilateral infiltration having the distribution of pulmonary edema. Subsequent films showed steady progression, with the maximal involvement becoming evident on May 1, 1957 (Fig. 2, B). With steroid therapy there was gradual improvement so that by June 11, 1958 (Fig. 2, C) there was almost complete clearing. This patient is living, and lung biopsy was not performed. The case appears to be identical with those reported by Doub, Goodrich, and Gish (12), which were associated with polyarteritis nodosa.

CASE III: J. G., an 11-year-old Mexican girl, had been under observation and treatment for two years. Although she had arthritic symptoms, her clinical picture was dominated by bleeding from many sites due to a circulating anticoagulant. Her L. E. test was positive. She had been under prolonged and massive steroid therapy.

Roentgenologically this patient showed, at various

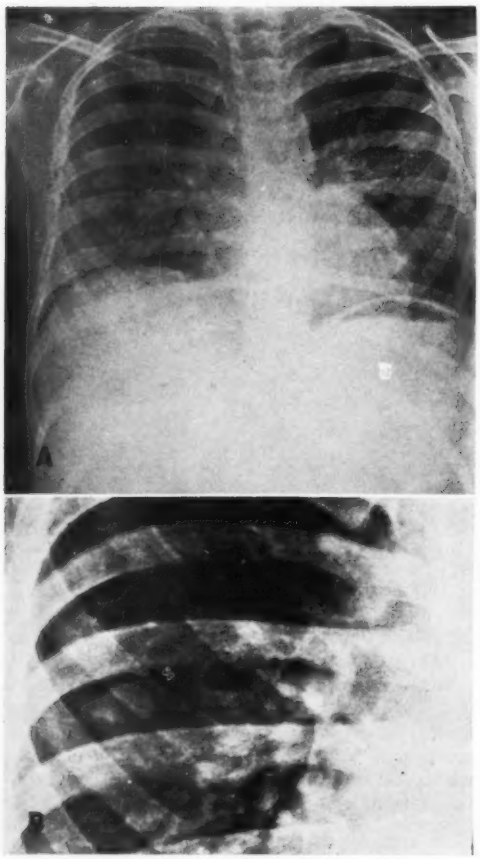


Fig. 3. Case III. A. Unusual spherical or nodular infiltrates in right mid-lung, one showing cavitation.
B. Nodular infiltrates shown in Fig. 3, A, enlarged view.

times, almost all of the thoracic phenomena seen in systemic lupus erythematosus: recurring pleural effusions and pneumonias, variations in cardiac size, and, on one occasion, pulmonary edema. The most unusual abnormality, however, was the appearance of spherical lesions, at least one of which showed cavitation (Fig. 3). These persisted for about one month with little change and then gradually diminished. Three months after their appearance there were no roentgenologic residues. This manifestation seems consistent with the necrotizing granulomatosis of Kornblum and Fienberg (13), Fienberg (14), and Rogers and Roberto (15).

The patient expired several months after disappearance of the nodular infiltration, and, at autopsy, was found to have miliary cryptococcosis in addition to the changes of systemic lupus. The waxing and waning of the roentgenologic changes seem inconsistent with cryptococcosis, although the massive terminal infection (undoubtedly influenced by steroid therapy) makes impossible accurate radiologic-pathologic correlation.

COMMENT

The extreme variability in incidence of abnormalities on chest roentgenograms in lupus erythematosus as reported in the literature is inexplicable. Neither method of diagnosis, stage of the disease, nor radiologic coverage suffice to explain it.

The greatest difference between our series and others is the large number of chest roentgenograms showing no abnormality. This is unexplained but is not based upon any difference in method of diagnosis or duration of the disease. In cases coming to autopsy in which the films had been negative there was often predominant and almost exclusive involvement of a single organ system, such as the central nervous system or hematopoietic organs.

Percentage frequency of abnormalities is influenced by the large number of negative examinations in our series (Table II).

TABLE II: ROENTGEN MANIFESTATIONS IN SYSTEMIC LUPUS ERYTHEMATOSUS IN OTHER SERIES AS COMPARED WITH THE PRESENT SERIES

Organ or Tissue Involved	Gould and Daves (100 cases) %	Garland and Sisson (32 cases) %	Moersch, Purnell, and Good (52 cases) %	Israel (22 cases) %	Present Series (207 cases) %
Pleura	74.0	40.6	19.2	9.0	35.3
Lung	50.0	31.2	34.6	68.1	12.6
Heart	53.0	31.2	5.7*	...	37.1
No abnormality	†	34.3	34.6	9.0	46.5

* This percentage represents cases with isolated cardiac involvement. Association of cardiac with other involvement was variable and not tabulated.
† The number of negative examinations in this series is not tabulated but, with 74 per cent having pleural changes, could not have been over 26 per cent.

TABLE III: TABULATION OF ROENTGENOGRAPHIC CHANGES IN 207 CASES*

	Unilateral Effusion Number	Bilateral Effusion Number	Thickening Only Number	Total Number	Total Per Cent of 207 Patients
Negative for Any Abnormality 96 (46.5%)					
Pleural Changes					
Pleural changes only	15	8	3	26	12.6
Pleural and cardiac changes	14	17	3	34	16.4
Pleural and pulmonary changes	1	2	..	3	1.4
Pleural, cardiac, and pulmonary changes	4	2	..	6	2.8
TOTAL	34 (17%)	29 (14%)	6	69	33.2

	Cases
Cardiac Changes†	
Cardiac changes only	25
Cardiac and pleural changes	34
Cardiac and pulmonary changes	7
Cardiac, pleural, and pulmonary changes	6
TOTAL	72 (34.9%)
Pulmonary Changes	
Incidental disease not related to S. L. E. (tuberculosis, etc.)	5
Pulmonary edema	5
Pneumonia, resolving promptly, as a single event	7
Pneumonia, resolving promptly, recurrent	4
Nonspecific, localized infiltration, duration unknown	2
Rapidly progressive, massive, terminal pneumonia	1
Long standing consolidation	1
Variable, patchy, and nodular, recurrent infiltrations	1
TOTAL	26 (12.6%)
Association of Pulmonary with Other Involvement	
Pulmonary lesions only	10
Pulmonary and cardiac changes	7
Pulmonary and pleural changes	3
Pulmonary, pleural, and cardiac changes	6
TOTAL	26 (12.6%)

* Maximal changes used as basis for classification and all abnormalities included.

† In only 3 instances was proved pericardial effusion the sole cause of the cardiac enlargement. In the majority of cases, pericardial, myocardial, and other factors such as anemia and hypertension contributed in varying degree to changes in the cardiac shadow.

TABLE IV: RELATIONSHIP BETWEEN DURATION OF DISEASE AND MAXIMAL ROENTGENOLOGIC ABNORMALITY

Duration	Negative (96 cases) %	Pleural Changes With or Without Other Pathology (69 cases), %	Cardiac Changes With or Without Other Pathology (72 cases), %	Pulmonary Changes With or Without Other Pathology (26 cases), %	Total, %
Under 1 yr.	24	8	13	12	14
1–1.9 yr.	15	21	18	19	18
2–5.9 yr.	31	47	42	39	40
6–9.9 yr.	15	7	11	15	12
10 yr. or over	15	17	16	15	16

Considering this, the variability in incidence of abnormalities between our series and others is relatively moderate.

The multisystem involvement generally characteristic of the disease is reflected in chest roentgenograms since, when any abnormality is manifest, combinations of lesions in heart, pleura, and lung are much more common than single organ or tissue involvement. Further, it is our impression that there is much greater tendency for rapid change in both pleural effusions and heart size when multiple involvement exists than when pleura, heart, or lung are affected singly. This may well reflect dissemination of the disease.

Our findings tend to confirm reports of the fibrinous nature of the pleural exudate

and the impossibility of assigning a single cause of cardiac enlargement in a given case.

Pulmonary changes were relatively infrequent and nonspecific. Long standing consolidation, pulmonary nodulation showing rapid change, and persistent infiltration having the distribution of pulmonary, edema constitute interesting phenomena and one should be aware of their possible occurrence in this disease. However, such lesions are rare.

CONCLUSIONS

1. The protean manifestations of systemic lupus erythematosus, variations in clinical material from series to series, differences in roentgen coverage, and perhaps other factors have resulted in such extreme variability in the reported incidence of roentgenographic changes in the chest that one must beware of drawing conclusions upon the basis of any single study.

2. Although it is unusual, systemic lupus erythematosus may exist for many years and even terminate fatally without any roentgenographically demonstrable thoracic abnormality.

3. Pleural and cardiac changes are almost equally frequent and are often combined. Effusions are generally small, with residual thickening the rule. In from one-third to one-half the cases involvement is bilateral. Cardiac enlargement is usually minimal to moderate, and rarely is the etiology apparent.

4. When the disease is manifest in several intrathoracic structures, rather than a single one, rapid serial film changes become far more frequent. This may be a reflection of dissemination.

5. Involvement of the lungs is less frequent than that of pleura or heart and is not specific for the disease. Interesting rare types of infiltration occur.

George Jacobson, M.D.
1200 North State Street
Los Angeles 33, Calif.

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SUMMARIO IN INTERLINGUA

Alterationes Thoraco-Roentgenographic in Systemic Lupus Erythematose

Le variabilissime manifestationes de systemic lupus erythematose, insimul con differentias del materiales clinic ab un serie al altere, differentias de completitate in le studios radiologic, e forsan altere factores ancora, ha resultate in si extreme variationes del reportate incidentia de alterationes roentgenographic in le thorace

que on debe esser extrememente caute in le formulation de conclusiones super le base de un studio individual.

Il es possibile, ben que inusual, que systemic lupus erythematose existe durante multe annos e se termina mesmo in le morte del patiente sin que ulle roentgenographicamente demonstrabile anormalitate thoracic ha unquam occurrite.

Quasi le mesme frequentia es illo del alterationes pleural e cardiac le quales occurre in multe casos in combination. Effusiones es generalmente micre, e spissification residue es le regula. Illos es bilateral in inter un tertio e un medietate del casos. Allargamento cardiac es usualmente de grado minime o moderate; le etiologia es rarmente apparente.

Quando le morbo es manifeste in plure structuras intrathoracic plus tosto que in un sol, rapide alterationes in roentgenogrammas serial deveni multo plus frequente. Isto es possibilemente un reflexion de dissemination.

Affection del pulmones es minus frequente que illo del pleura o del corde; illo non es specific pro iste morbo. Le occurrentia de rar e interessante typos de infiltration ha essite notate.

Es includite le reportos de 3 casos.

Post-Pneumonic Pulmonary Pneumatoceles[1]

LIEUT. COL. ROBERT A. FLAHERTY, LIEUT. COL. JAMES M. KEEGAN, and MAJ. HARWOOD N. STURTEVANT, USAF(MC)

PULMONARY pneumatoceles are areas of regional obstructive emphysema usually developing as a complication of staphylococcal pneumonia. They are thin-walled, air-containing, cyst-like structures which may occur at any age but are most frequently seen in infancy (Fig. 1). The majority of the recorded cases have been in infants and young children (1–4). Snider and Radner cite a few reports describing pneumatoceles in adults (5).

The purpose of this paper is to report 20 cases in which pulmonary pneumatoceles developed as a complication of pneumonia; 8 of the patients were children and 12 were adults. The etiologic factor in most cases in both age groups was staphylococcal pneumonia. In view of the increase in the occurrence of this disease in the past several years we believe that it is important to understand the mechanism of development, roentgenographic appearance, and ultimate prognosis of pulmonary pneumatoceles.

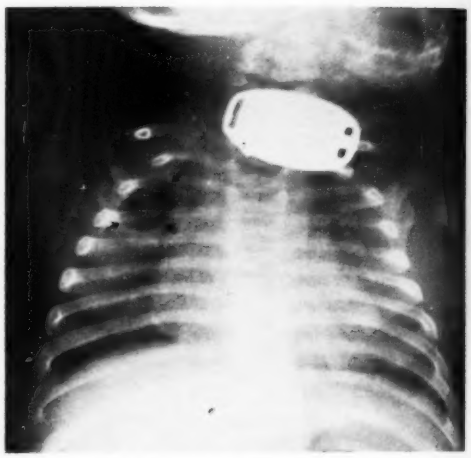

Fig. 1. Pneumatocele in right upper lobe in an infant, which developed during resolution of a staphylococcal pneumonia.

MECHANISM OF DEVELOPMENT

Pneumatoceles are believed to be the result of localized obstructive emphysema secondary to inflammatory narrowing of a bronchus. Potts and Riker (6) believe that their frequent occurrence in staphylococcal pneumonia is explained by the nature of the inflammatory process. It is their belief that a small area of necrotic lung is evacuated into a bronchus which is already narrowed by the inflammatory reaction and edema accompanying the pneumonia. The combination of a cavity communicating with a bronchus, narrowing of the bronchus by edema, and the normal expiratory bronchial constriction present an ideal combination of factors for the production of an area of obstructive emphysema. This small necrotic space then enlarges until a fully developed pneumatocele is formed.

CLINICAL FEATURES

The most significant feature in patients with pulmonary pneumatoceles is the paucity or absence of symptoms after the pneumonitis resolves and the pneumatocele remains.

All of our patients initially had clinical evidence of pneumonia and during this phase were symptomatic. As the pneumatocele developed, however, the pneumonitis usually resolved and the symptoms disappeared. At the time that the pneumatocele was fully developed, none of the patients had symptoms relative to its presence, and 18 of the 20 were completely asymptomatic. In the 2 exceptions the pneumonia was complicated by a pyopneumothorax.

There is such a close relationship be-

[1] From the Department of Radiology, United States Air Force Hospital, 3700th Military Training Wing (ATC), Lackland Air Force Base, Texas. Accepted for publication in January 1959.

The contents of this paper reflect the personal views of the above authors and are not to be construed as a statement of official Air Force policy.

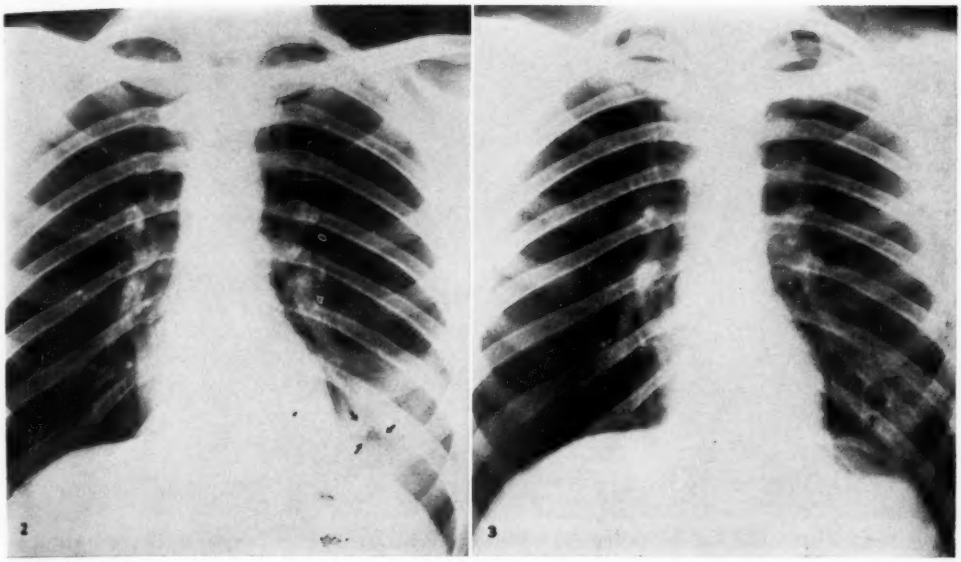

Fig. 2. Small irregular air space within an area of pneumonitis in the anterior medial basilar segment of the left lower lobe.

Fig. 3. Same case four days later. As the pneumonia resolved, the thin-walled pneumatocele appeared. It increased slightly in size, remained for six weeks, and then disappeared.

tween staphylococcal pneumonia and pneumatocele formation that the development of an air space within an area of pneumonia should be suggestive evidence that a staphylococcal pneumonia is present.

Wherever possible the etiologic organism was identified in our cases. Fourteen of the entire group, 5 infants and 9 adults, had proved staphylococcal pneumonia. Four had been treated prior to our observation and the causative organism was not recovered and in 2 cases the organism could not be definitely identified.

ROENTGENOGRAPHIC FINDINGS

We have observed the entire sequence of the development and regression of pulmonary pneumatoceles in many of the cases which we are reporting. When first identified a pneumatocele appears as a small air space within the area of pneumonia (Fig. 2). As it enlarges, the wall may appear thick and its inner surface may be somewhat irregular in appearance. Usually, however, the inner surface appears smooth and the thickness of the wall cannot be determined because of the surrounding pneumonia. As the pneumonia resolves the typical thin-walled, air-filled cyst appears (Fig. 3). It may disappear rapidly with continued resolution.

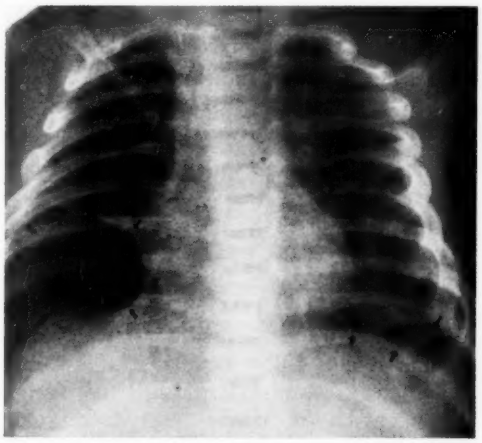

Fig. 4. Roentgenogram of an infant who had had staphylococcal pneumonia involving portions of both lower lobes. There are a large pneumatocele in the right lower lobe and several small pneumatoceles in the left lower lobe.

Pulmonary pneumatoceles are often single but it is not unusual to see more than one developing in an area of pneumonia or

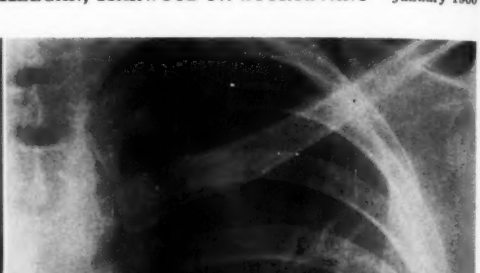

Fig. 5 (left). Pneumatocele developing as a complication of stapholococcal pneumonia. It was resected two weeks after complete resolution of the pneumonia because it was thought to be a residual abscess cavity. Microscopic examination showed neither inflammatory nor fibrous elements in the cyst wall. As in other emphysematous bullae, the wall of a pneumatocele is formed by compression of the surrounding lung.

Fig. 6 (right). This pneumatocele could easily be confused with a thin-walled cavity occurring in coccidioidomycosis.

to see them developing simultaneously in multiple areas (Fig. 4).

They may contain fluid but usually are completely air-filled. Some fluid was present in 2 of our cases. In 1 of these the pneumatoceles were multiple but fluid was present in only one.

The largest pneumatocele we encountered measured 6 cm. in diameter, the smallest 2 cm. All attained their maximum size within a relatively short time of their onset and resolution of the pneumonia. Once fully developed, they all remained the same size until regression began, with a single exception. One fluctuated somewhat in size before it eventually regressed.

Pneumatoceles will practically always disappear in a period of weeks or months following their onset. All of those which we have observed have disappeared within three months, except for one which was resected (Fig. 5). In most of our cases the pneumatoceles vanished completely between follow-up roentgenograms, taken at two-week intervals. Because of this we do not know whether they disappeared slowly or rapidly collapsed. In 2 cases we observed that the pneumatocele decreased gradually in size over a period of days before it completely disappeared. Following collapse, a residual thin, fibrotic-appearing strand remains in the area, representing the wall of the former cyst. We have not observed recurrence or re-expansion after complete collapse.

DIFFERENTIAL DIAGNOSIS

The differentiation of a pneumatocele and a lung abscess may be difficult or impossible from the roentgenographic picture. When fluid is present in the pneumatocele the appearance may be identical to that of abscess. Usually, however, the wall of the pneumatocele appears thinner and less irregular than the abscess wall. The appearance or persistence of these cysts as the pneumonia resolves—particularly persistence after the complete disappearance of symptoms—is helpful in establishing their true nature.

We have observed several cases of localized pyopneumothorax which were difficult to differentiate from a pneumatocele. As

both conditions readily occur in staphylococcal pneumonia, it should not be unusual to see both in the same patient. Two of our patients had pneumatoceles within the lung associated with loculated pyopneumothorax. We were unable to define both conditions when evaluating roentgenograms taken during the early stage of the pyopneumothorax but when drainage had been established the pneumatoceles could be identified.

Pneumatoceles occurring in infants must be differentiated from congenital cysts of the lung and lobar emphysema. The history of a preceding respiratory infection may be obtained in pneumatoceles but not usually in the other two conditions.

When a pneumatocele occurs in an adult it is quite possible to confuse it roentgenographically with the thin-walled cavities which can occur in the mycotic infections, particularly coccidioidomycosis (Fig. 6). The clinical course and the recovery of *Staphylococcus aureus* in the early stage of the inflammatory process are the best means of differentiating pneumatoceles from cavities of a more serious nature. If this is not possible, skin sensitivity tests may be of help in excluding tuberculosis and coccidioidomycosis. Occasionally a squamous-cell carcinoma of the lung will cavitate and present as a thin-walled, air-containing structure. The history of a recent pneumonia will usually exclude this diagnosis.

CONCLUSION

Twenty cases of lesions having the clinical and roentgenographic characteristics of pulmonary pneumatocele have been reported. Eight were in children, 12 were in adults.

Pulmonary pneumatoceles probably begin as small abscesses but continue to enlarge and develop as localized areas of obstructive emphysema. Pneumatoceles do not produce symptoms unless they enlarge sufficiently to embarrass respiration. They occasionally contain fluid but most often are completely air-filled. They occur during and following pneumonia, usually staphylococcal in origin, and they almost invariably regress spontaneously.

ACKNOWLEDGMENT: We wish to thank Maj. B. G. Brogdon and Maj. Neil E. Crow for 2 cases which are included in this series.

Lutheran Hospital
Fort Wayne, Ind.

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SUMMARIO IN INTERLINGUA

Pneumatoceles Pulmonar Post-Pneumonic

Es reportate vinti casos de lesiones con le characteristicas clinic e roentgenographic de pneumatoceles pulmonar. In 8 del casos il se tractava de patientes pediatric. In le remanente 12 casos, le patientes esseva adulte.

Pneumatoceles pulmonar comencia probabilemente como micre abscessos, sed istos continua crescer e disveloppar se como localisate areas de emphysema obstructive. Pneumatoceles produce nulle symptomas, excepte quando illos deveni sufficientemente grande pro embarrasar le respiration. In certe casos illos contine liquido, sed in le majoritate del casos illos es completemente plenate de aere. Illos occurre durante e post pneumonia. Usualmente illos es de origine staphylococcal. Lor regression occurre quasi invariabilemente de maniera spontanee.

Localized Destructive Lesions in Rheumatoid Spondylitis[1]

MARK H. WHOLEY, M.D., DAVID G. PUGH, M.D., and WILLIAM H. BICKEL, M.D.

THE ORDINARY roentgenologic manifestations of rheumatoid spondylitis have been well described (1–4). Clinicians and roentgenologists are especially interested in recognizing the early phases of the disease, when treatment is often efficacious; little improvement can ordinarily be effected when the condition is far advanced. For that reason, little has been written concerning the late stages of the disease, except for descriptions of operative procedures that have been used to correct extensive deformity.

The so-called bamboo spine, in which the spinal column is completely ankylosed as the result of ossification of the vertebral ligaments, is easily recognized. It is usually stated that in these cases the vertebral bodies are osteoporotic and the intervertebral disks are narrowed but that neither structure is directly involved or affected by the disease (5).

This investigation was initiated by the observation that certain patients show striking destructive changes involving the intervertebral disks and adjacent vertebral bodies which, though closely resembling some type of infection, such as tuberculosis, brucellosis, or a pyogenic condition, constitute in reality just another manifestation of rheumatoid spondylitis.

Over a period of ten years (1947 through 1956), 10 patients with far advanced rheumatoid spondylitis and roentgenologic evidence of involvement of an intervertebral disk and adjacent bodies have been seen at the Mayo Clinic. This low incidence would indicate the rarity of this association. The localized destructive lesions in all 10 patients were similar roentgenologically, and biopsy of the affected area in 2 showed chronic inflammatory lesions. From this it is believed that involvement of the interverteoral disk and adjacent bodies represents destruction by a chronic inflammatory process resulting from the spondylitis. In all cases the lesions failed to show the progression that would be expected of other infectious or granulomatous processes; in 1 patient there was evidence of spontaneous healing without specific treatment.

All the patients were men. The average age at onset of symptoms was twenty-four years. In all instances, the disease had been in progress for at least ten years before exaggerated localized pain in the back led to further investigation. Roentgen examination then revealed the lesions affecting the intervertebral disk and adjacent vertebral bodies. As already noted, the specimens in the 2 cases in which biopsy was performed were considered histologically compatible with rheumatoid inflammation. Needle biopsy was done in another case but did not provide sufficient material for diagnosis. Results of cultures and smears for bacteria and fungi were negative in these 3 cases.

Characteristic roentgenographic features were destruction of the intervertebral disk and the margins of the adjacent vertebrae. Far advanced rheumatoid spondylitis shows ankylosis of the intervertebral spaces, the disks becoming narrowed and atrophic and the adjacent vertebral surfaces becoming smooth. With superimposed inflammatory involvement, the contiguous vertebral surfaces of the affected segments were destroyed and the space occupied by the disk was either widened or narrowed, indicating that the intervertebral cartilage was affected. Although involvement in most patients extended the length of the interspace, destruction of the intervertebral disk and adjacent vertebrae

[1] From the Mayo Clinic and Mayo Foundation, Rochester, Minn. (M. H. W., Fellow in Radiology; D. G. P., Section of Roentgenology, and W. H. B., Section of Orthopedic Surgery). The Mayo Foundation is a part of the Graduate School of the University of Minnesota. Accepted for publication in January 1959.

Fig. 1. Case I. Anteroposterior and lateral roentgenograms of the thoracic portion of the spinal column, showing rheumatoid spondylitis with destruction at the ninth intervertebral space and contiguous vertebral surfaces. Biopsy revealed a rheumatoid inflammatory reaction.

was most pronounced anteriorly. Early destruction was soon followed by osteosclerosis of the affected segment, indicating the presence of an active process.

This picture was in striking contrast to the condition of the remainder of the spinal column, which was invariably ankylosed and showed roentgen evidence of quiescence. The aforementioned localized activity certainly must be of low grade, since it underwent little or no progression over an average period of five years. As previously mentioned, one patient showed spontaneous resolution and subsequent ankylosis. In another instance, bone graft and fusion produced subsidence of activity, with bony healing and relief of the pain. All other patients were treated conservatively, with a combination of body casts, antirheumatic drugs, and physical or roentgen therapy. The thoracolumbar region was involved most frequently, with the process localized to two contiguous vertebrae and the corresponding intervertebral disk in the majority of patients.

The following reports describe 3 rather typical cases.

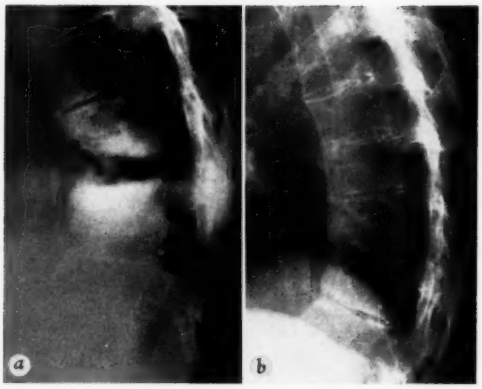

Fig. 2. Case II. Localized views of thoracic portion of spinal column, showing rheumatoid inflammatory destruction at the tenth and eleventh intervertebral spaces in a patient with rheumatoid spondylitis. Involvement of the vertebral body also is present.
a. Appearance in 1950. *b*. Appearance five years later, showing spontaneous fusion and ankylosis. Roentgenographic evidence of quiescence is present.

CASE I: A 29-year-old man was seen at the Mayo Clinic in 1946 with the complaint of pain of two and a half years duration in the interscapular region of the back. Clinical and roentgenographic evidence was characteristic of rheumatoid spondylitis, and the usual conservative measures for treatment of that condition were advised. In 1954, there was exacerbation of pain in the back, with localized tenderness in the lower thoracic region. Roentgenograms at that time showed destruction of the intervertebral disk and adjacent vertebral margins of the ninth and tenth thoracic vertebrae. Biopsy of the ninth intervertebral disk revealed histologic changes which were consistent with an inflammatory reaction. A short course of steroids and localized roentgen therapy to the involved region was instituted. In 1957, little change had occurred in the appearance of the spinal column, although moderate symptomatic improvement had taken place (Fig. 1).

CASE II: A 30-year-old man seen at the Clinic in 1930 had a fifteen-year history of intermittent pain in the lower part of the back. A diagnosis of rheumatoid spondylitis was made. In 1950, during an exacerbation of this pain, roentgenograms showed destruction of the tenth and eleventh thoracic intervertebral spaces and contiguous vertebral margins (Fig. 2, *a*). The findings were consistent with chronic inflammation related to the rheumatoid spondylitis. Over a period of five years, during which a conservative medical regimen was followed, the destructive lesions underwent spontaneous fusion, subsequently becoming quiescent (Fig. 2, *b*).

CASE III: A 32-year-old man came to the Clinic in 1951 for evaluation of repair of a diaphragmatic

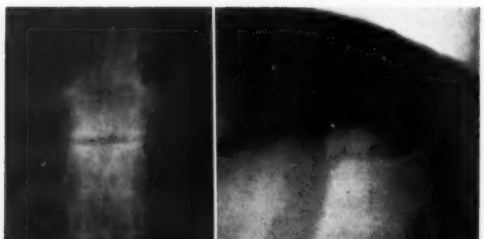

Fig. 3. Case III. Anteroposterior and lateral roentgenograms of the thoracic portion of the spinal column in a patient with far advanced rheumatoid spondylitis, showing rheumatoid inflammatory destruction at the eleventh thoracic interspace. The vertebral surfaces at this level are also involved.

hernia. He had had rheumatoid spondylitis for ten years. His symptoms were minimal, but examination demonstrated tenderness to percussion over the eleventh and twelfth thoracic vertebrae. Roentgenograms gave evidence of far advanced rheumatoid spondylitis with destruction at the eleventh thoracic interspace and contiguous vertebral margins (Fig. 3). The findings were clinically and roentgenologically consistent with an inflammatory process associated with the spondylitis.

COMMENT

In 1952, Baggenstoss and associates (6) reported 4 cases in which rheumatoid arthritis or spondylitis produced destruction in the region of the intervertebral disk and vertebral body. The lesion in 1 case was proved histologically to be a rheumatoid nodule affecting a vertebral body and associated with diffuse rheumatoid arthritis but without rheumatoid spondylitis. The other 3 cases were examples of rheumatoid spondylitis that fulfilled the roentgenographic and clinical criteria of a localized rheumatoid inflammatory reaction and have been included in the present series. When destruction of the intervertebral disk by this inflammatory reaction predominates, the roentgen appearance may simulate that of tuberculosis, brucellosis, or other specific infectious granulomas, but the association of this reaction with far advanced rheumatoid spondylitis should suggest the proper diagnosis. When involvement of a vertebral body is the principal feature, as was shown in the case reported by Baggenstoss *et al.*, then the appearance may suggest malignant metastatic destruction and the correct diagnosis may be made only by biopsy.

SUMMARY

Destruction of the intervertebral disk and vertebral body by rheumatoid inflammation in patients who have rheumatoid spondylitis or arthritis is not widely recognized. Ten cases of far advanced rheumatoid spondylitis in which this destruction was a predominant feature were encountered in a ten-year period at the Mayo Clinic. It is important to consider the possibility of such rheumatoid inflammatory reactions when localized vertebral lesions are seen in patients with rheumatoid spondylitis

Mayo Clinic
Rochester, Minn.

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(*Pro le summario in interlingua, vider le pagina 60*)

Antemortem Radiographic Demonstration of Gas Gangrene of the Liver[1]

MATTHEW W. ELSON, M.D.

A SEARCH OF THE literature has failed to reveal a case of gas gangrene of the liver with positive radiographic findings before death. In fact, the *in vivo* existence of such a disease entity has been denied by some, although one case has been reported in which the autopsy findings indicated that gas gangrene may have been present prior to death (1).

CASE REPORT

A 75-year-old white female who was blind, diabetic, and hypertensive was admitted to the hospital with a temperature of 25.5°C., and a diagnosis of urinary tract infection was made. The patient responded slowly to antibiotic therapy but after thirteen days again became febrile and began vomiting black, liquid material, at the same time complaining of marked abdominal pain. Gradually the abdomen became distended, tympanitic, and diffusely tender. During the next twenty-four hours intermittent episodes of hematemesis occurred, and, in spite of supportive measures, the patient went into shock. The clinical impression was a perforated appendix or colon with diffuse peritonitis.

At this time a postero-anterior roentgen examination of the chest (Fig. 1) and a supine examination of the abdomen (Fig. 2) showed numerous isolated and confluent clusters of gas bubbles corresponding in location to the entire right lobe of the liver. There was also a small amount of free air beneath the right leaf of the diaphragm. Death ensued shortly after the radiographic examination.

When the peritoneum was incised at autopsy, a large amount of malodorous gas escaped. About 200 c.c. of thick, yellowish exudate covered the anterior and upper surfaces of the liver, which weighed 2,500 gm. and extended 4 cm. below the costal margin. There was crepitation in an area on the anterior surface of the right lobe, measuring 9 × 7 cm. and of a dark bluish-red and black color. On cross section, this portion of the liver was seen to be transformed

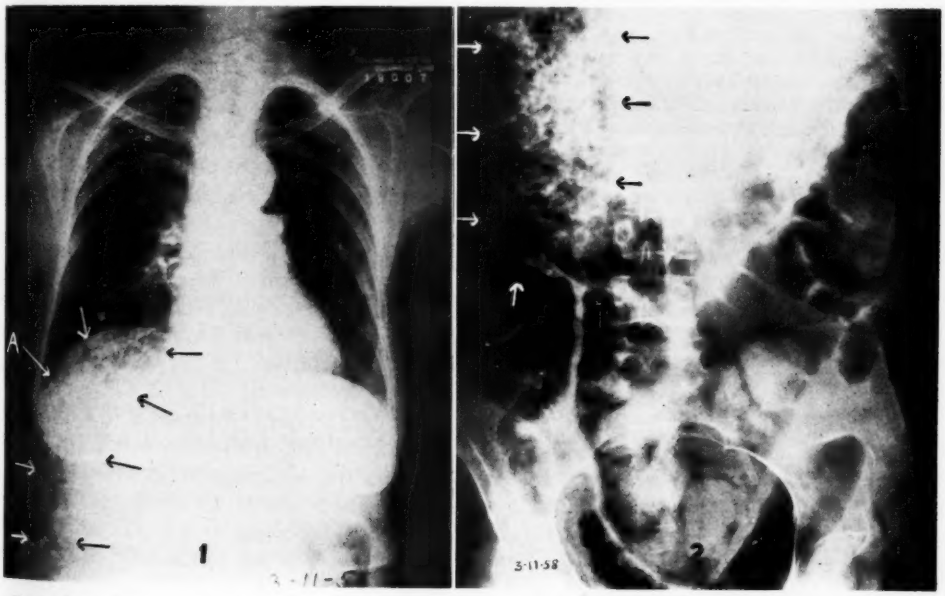

Fig. 1. Postero-anterior roentgenogram of chest. Clusters of gas bubbles occupy an extensive area beneath the right leaf of the diaphragm. Note also the small amount of free gas beneath the diaphragm (A).
Fig. 2. Supine examination of the abdomen. The location of the gas vesicles corresponds to the right lobe of the liver.

[1] From the Department of Radiology, Ohio State Medical Center, Columbus 10, Ohio. Accepted for publication in January 1959.

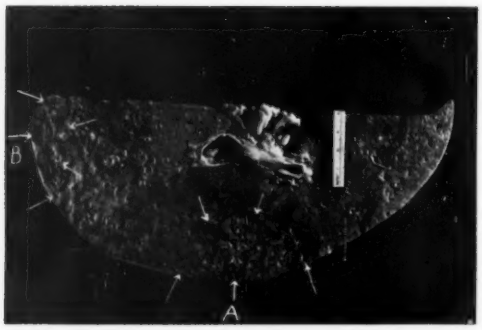

Fig. 3. Cross section of the liver. Note the necrotic, gas-filled portion of the anterior surface of the right lobe (A) and a similar area of involvement more laterally (B).

into a soft, mushy, dark-red mass with complete loss of the lobular pattern (Fig. 3). The splenic and portal veins were empty, smooth, and thin-walled.

A low-power microscopic view (Fig. 4) showed an irregular disruption of the hepatic tissue by gas bubbles and an area of hemorrhage. A high-power view of the same area (Fig. 5) demonstrated degenerating liver parenchymal cells and numerous gram-positive spore-bearing bacilli.

The gallbladder was reduced to a thick, white cord, 2 × 0.7 cm., covered with dense adhesions apparently due to previous inflammatory processes. The common bile duct was about 1 cm. wide and had a thin, pliable wall with a well preserved mucosa.

The final histopathologic diagnosis of the liver disease was multiple abscesses and extensive necrosis due to an anaerobic infection. Numerous clostridial organisms were found throughout the liver without signs of active inflammation of the intrahepatic biliary ducts. The disease was widespread, as evidenced by the finding of necrotizing gastritis with gas formation in the submucosa, septic infarcts of the spleen, and necrotizing renal papillitis, all the result of the anaerobic infection.

DISCUSSION

Any of three members of the genus *Clostridium* independently produce gas gangrene: *Clostridium welchii* (*perfringens*), *Clostridium oedematiens*, and *Clostridium septicum*. The *Clostridia* responsible for gas gangrene are strictly anaerobic, gram-positive, spore-bearing organisms, and their growth is entirely saprophytic. The factors which stimulate initial growth and production of toxin are not well understood in spite of considerable study. Once the organisms have begun to grow and produce exotoxin, continuation of the process is assured. As the soluble toxin diffuses into surrounding tissues, it produces an ever-expanding wave of necrosis, which provides dead tissue for additional growth of the Clostridia and the production of still more toxin.

Much of our knowledge regarding clostridial organisms has been derived from animal work. Wolbach and Saiki (2) in 1909 discovered an anaerobic, spore-bearing, nonmotile bacterium in 21 of 23 healthy dog livers incubated for forty-eight hours. They believed the presence of this organism in the livers of normal dogs may produce many changes in the so-called aseptic autolysis of liver tissue. In 1927 Berg *et al.* (3) kept 11 dogs without food for eighteen hours and then obtained bile from the gallbladder and a wedge of liver tissue. In every dog the bile was sterile, but the liver tissue from all the animals yielded a pure culture of an anaerobic spore-bearing bacterium. About the same time Reith (4) recovered anaerobes from 49 per cent of cultures of muscular tissues of healthy live hogs, rabbits, and guinea-pigs. Eliason and his co-workers (5) extended the concept of the prevalence of the *Clostridia* when they found gram-positive spore-bearing anaerobes on the skin of 21.7 per cent of unprepared surgical abdomens and on 8.5 per cent of the knife-blades used for surgical incision. When the abdomen was opened for noninflammatory conditions, the organism was found within the peritoneal cavity of 9.2 per cent of the cases. Other workers (6, 7) found *Clostridium welchii* in 9 per cent of gallbladders removed surgically and in 13 per cent of all gallstones at routine postmortem examinations.

The appearance of these gas vesicles in the liver is similar to the gas collections in pancreatic abscess formation described by Felson (8) and later by Agnos and Holmes (9). Culture material from 1 of the 2 cases reported by the latter grew "*Streptococcus viridans* and occasional *Clostridium welchii*." Cultures obtained in 2 of Felson's 6 cases yielded *Escherichia coli*

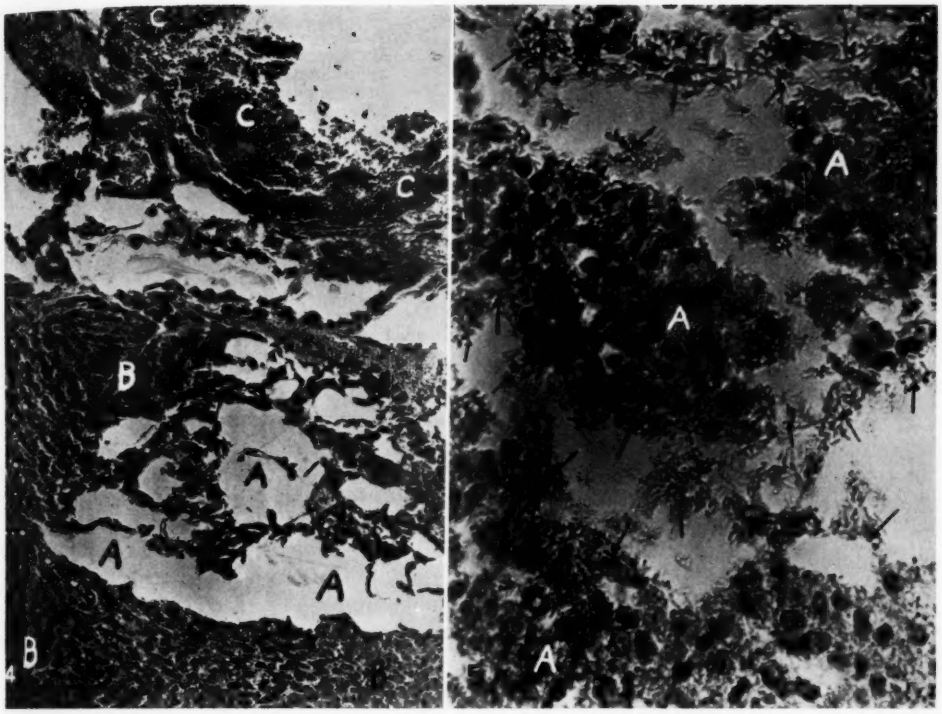

Fig. 4. Low-power view of the liver (hematoxylin and eosin. × 75). Collection of gas bubbles (A) within the liver parenchyma (B) and an area of hemorrhage (C).

Fig. 5. High-power view of the lesion shown in Figure 4 (Gram stain. × 650). The arrows point to numerous clusters of gram-positive spore-bearing bacilli within gas vesicles and along the margins of degenerating liver cells (A).

in 1, while the other was sterile. Felson described the radiographic appearance of the gas collections as "similar to that of fecal matter." He also stated that gas production in the tissues by clostridial organisms is well known but that gas may also be produced by such organisms as *Klebsiella*, *Proteus*, and *Escherichia coli*. It should be noted, however, that these latter are gram-negative bacilli, whereas in the presently reported case the bacterium was gram-positive and spore-bearing, these characteristics identifying it as a clostridial organism.

Only one case of gas gangrene in the liver suspected during life could be found in the literature (1). The patient was a sixty-year-old female who had undergone a cholecystectomy and exploration of the common duct with the insertion of a T-tube for drainage. Shortly after the removal of the T-tube, an episode of hematemesis with melena occurred, followed by death. Autopsy revealed gas gangrene in the liver, with huge numbers of *Clostridium welchii*. It was concluded that this was antemortem gas gangrene of the liver, since clostridial organisms had not been previously shown in such large numbers in the usual postmortem foamy liver.

SUMMARY

A case is reported of clostridial infection in a diabetic patient. Many workers have demonstrated that gram-positive, spore-forming anaerobes are widely distributed in nature, are relatively avirulent, and require an ideal environment to become pathogenic. The present case demonstrates that gas gangrene in the liver, as shown by roentgenograms and

by subsequent pathological examination, may develop prior to death.

University Hospital
11th and Neil Aves.
Columbus 10, Ohio

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SUMMARIO IN INTERLINGUA

Demonstration Radiographic Ante Morte de Gangrena Gasose in le Hepate

Es reportate le apparentemente prime caso de un definitive demonstration radiologic ante morte de clostridial gangrena gasose del hepate. Le diagnose esseva confirmate subsequentemente al necropsia. Il es possibile que le infection habeva su origine in le renes o vias gastrointestinal. Con le disveloppamento subsequente de metastases in splen, stomacho, e hepate.

Multe investigatores ha demonstrate que Gram-positive anaerobios sporifere es extensemente distribuite in le natura, que illos es relativemente avirulente, e que illos require un ambiente ideal pro devenir pathogene. Le caso reportate in iste articulo demonstra que gangrena gasose pote disveloppar se in le hepate ante le morte del patiente.

SUMMARIO IN INTERLINGUA

Localisate Lesiones Destructive in Spondylitis Rheumatoide

(*Pagina 54*)

Le destruction del disco intervertebral e del corpore vertebral per le effecto del inflammation rheumatoide in patientes con spondylitis o arthritis rheumatoide es un condition rar que non es extensemente recognoscite. Dece casos de avantiatissime spondylitis rheumatoide in que iste destruction esseva un aspecto predominante esseva incontrate in le curso de un decennio al Clinica Mayo. In omne iste casos le lesiones non exhibiva le progression que on expectarea de altere processos infectiose o granulomatose. Un patiente monstrava signos de curation spontanee sin tractamento specific. Es importante considerar le possibilitate de tal reactiones inflammatori rheumatoide quando localisate lesiones vertebral es incontrate in patientes con spondylitis rheumatoide.

Tres casos es reportate in detalio.

Axial Transverse Laminagraphy Applied to Rotational Therapy[1]

S. TAKAHASHI, M.D., and T. MATSUDA, M.D.

It is essential in rotational therapy that the radiation beam should strike the area to be treated without error; otherwise, this procedure loses its significance and becomes injurious rather than beneficial to the patient. Accurate knowledge of the size and location of the lesion in the cross section of the body is thus essential. Once this is obtained, it becomes possible to center the lesion accurately in relation to the rotating radiation source and determine the size of the radiation field.

The rotational therapy unit in the hospital of the University of Nagoya (Japan), housing a 2,000-c cobalt-60 source, was constructed for irradiation of patients supine upon the therapeutic table. As a first step in the procedure, a roentgenogram is obtained of the cross section of the patient in this same position. For this purpose we have constructed a "universal rotatograph" (1). This apparatus (Figs. 1 and 2) consists of a rectangular iron frame, with a rack for installing the tube (T_1) on the upper part and a rack for the film (F) on the lower. Unattached to this rectangular frame, and almost vertically below the x-ray tube, is the radiographic table (B), the structure of which is the same as that of a therapeutic table. Attached to the lower part of the vertical frame is a rotating axis (C) affording free rotation through 0 to 190°. The film (F) is rotated simultaneously with this. Rotation is accomplished at uniform speed by an electric motor (M). The focal spot of the x-ray tube, the rotation center of the frame, and the rotation center of the film are contained in a plane. The tube (T_1) is set in such a position that the central beam makes an angle of 20° with the film surface. Though the frame rotates freely, the x-ray table remains at rest during radiography.

With the patient on the roentgenographic table in a posture similar to that for therapy, necessary adjustment is made so that the lesion will be in the vertical plane containing the rotation center, C, of the tube T_1. A second x-ray tube, T_2, serves for checking this. The patient is asked to hold his breath. The x-ray tube T_1 is then rotated through the full scale around the patient, and during this rotation exposure is made. For a film of the pelvis in an adult the factors are 85 kv, 30 ma, 8 seconds; the distance between the x-ray tube and the rotation axis (C) of the frame is 148 cm., and that between the rotation axis and the center of the film 46 cm. Under these conditions an axial transverse laminagram (2–5) is taken.

The x-ray image thus obtained is similar in shape to the actual cross section of the body. There is no distortion, except for the magnification (× 1.3). The layer of the cross section visualized is considered to be about 0.5 mm. thick. Thus the contour of the cross section of the body and the actual, or at least suspected, status of the lesion are revealed, and the distance of the lesion from the surface of the body in the sagittal and frontal planes can be measured. By reference to the roentgenogram, the skin is marked at the points intersected by these planes.

The patient is now placed on the therapeutic table, the light localizer attached to the cone of the radiation source being used to assure the right position. When the center of the light field of the localizer hits the marks on the skin from four directions, the lesion is considered to be at the center of rotation.

For lesions located eccentrically in relation to the center of the cross section, the mode of rotation is adapted to the arc therapy method. The range of the angle of rotation is determined by the roentgeno-

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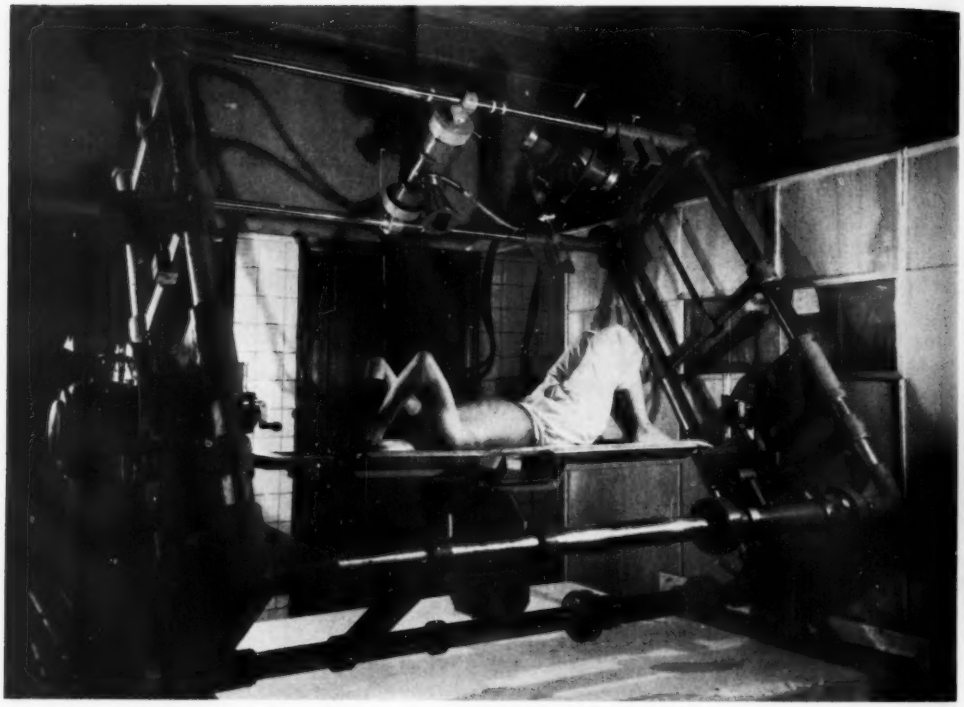

Fig. 1. Universal rotatograph in use.

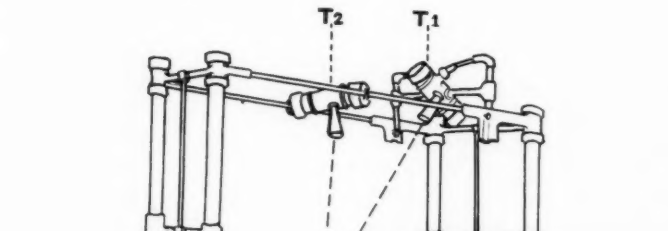

Fig. 2. Diagram of universal rotatograph.

gram. The field size to be irradiated at the depth of the lesion is measured also by inspection of the laminagram. The size of the mouth of the cone is set accordingly and irradiation is carried out.

For rotational therapy, several technics have been used to adjust the lesion to the position of the rotation center. Routine roentgenograms or fluoroscopic examination made in two projections at right angles have been believed to be useful for determining the distance between the surface of the body and the lesion. According to our experience (8), the actual distance is

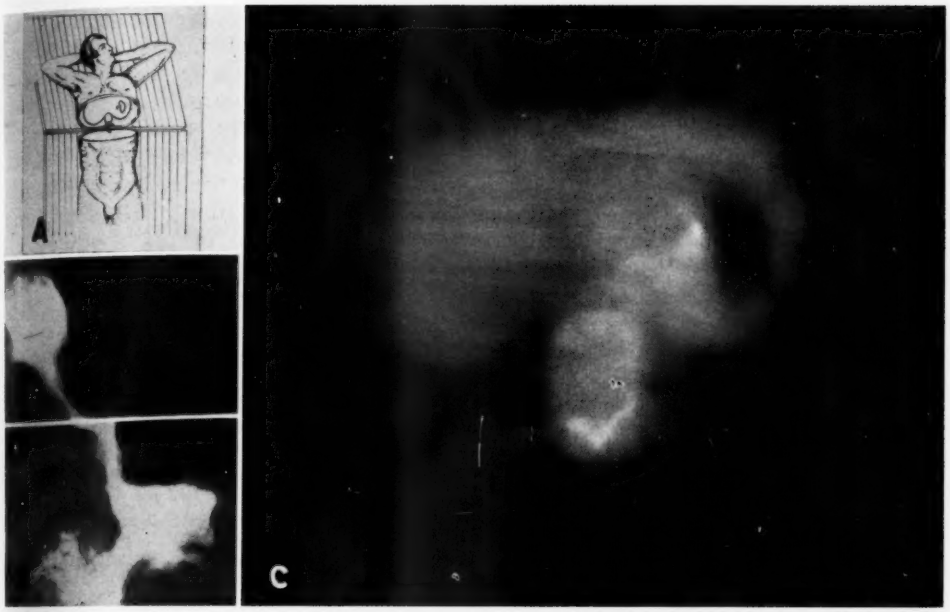

Fig. 3. Cross-section roentgenogram in a case of recurrent gastric cancer causing esophageal stenosis. Patient erect. A. Diagrammatic representation of right roentgenogram. B. Routine film of the stomach. The straight horizontal line indicates the level of cross section. C. Axial transverse laminagram.

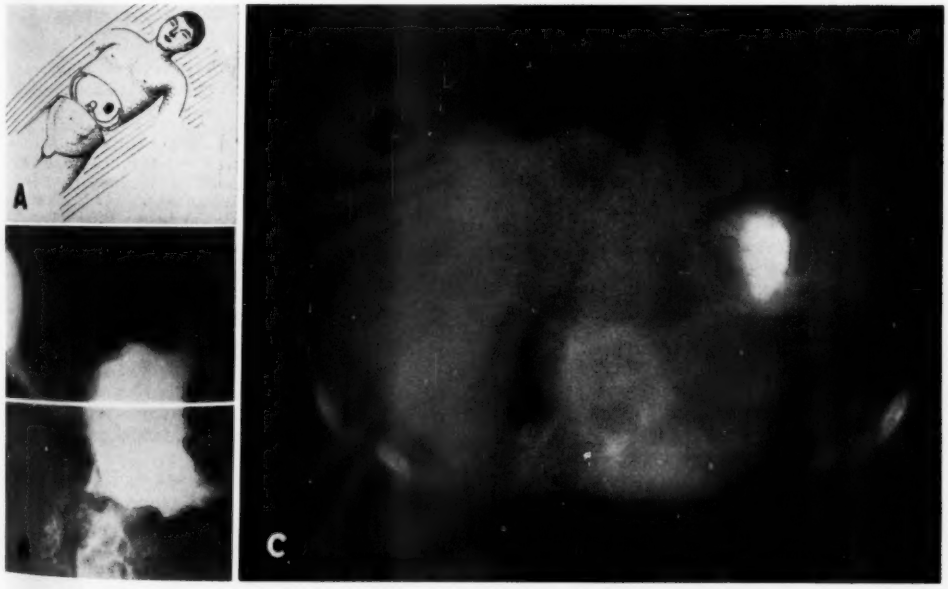

Fig. 4. Same patient as in Fig. 3. Cross section in supine position.
A. Diagrammatic representation of right roentgenogram. B. Routine film of the stomach. The straight horizontal line indicates the level of cross section. C. Axial transverse laminagram taken with universal rotatograph.

obtained with difficulty by this method, especially when the lesion is relatively radiopaque or is located in a part of the body with complicated structure.

Various methods have been described (9, 10) for determining the contour of the body cross section, notably the use of a lead belt around the body and the contour meter of Friedman, but there remain the problems of the location, shape, and size of the lesion, which are of prime importance in rotational therapy. From this point of view, our method is of value in that it reveals clearly and concretely these aspects.

To get an x-ray image of the cross section of the body, axial transverse laminagraphs have occasionally been made with the patient erect. The cross section, however, changes in shape with change to the supine position, the difference being greatest in examination of the chest and abdomen (Figs. 3 and 4). Roentgenograms in the erect position are thus scarcely applicable to rotational therapy in the lying posture.

The type of roentgenogram described here is most convenient for calculation of the depth dose (11). Without this procedure, reliable dose figures are difficult to obtain since their calculation, as by Johns (12), is based on a knowledge of the actual cross section of the body and the exact location and size of the lesion. The tumor-air ratio is obtained by calculation based on measurement of the distance of the skin from the lesion in all directions.

SUMMARY

A procedure is described for obtaining a roentgenogram of the cross section of the body with the patient supine as for rotational therapy. This roentgenogram, or an axial transverse laminagram, provides information not only as to the body contour but also as to the exact location and size of the lesion to be treated. It makes possible accurate positioning of the patient with the lesion at the center of rotation and permits calculation of the size of the radiation field and of the depth dose.

Hospital of the University of Nagoya
Showaku, Nagoya, Japan

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SUMMARIO IN INTERLINGUA

Laminographia Transverse Axial, Applicate a Therapia Rotational

Es describite un technica pro le obtention de un roentgenogramma del section transverse del corpore, con le patiente in decubito dorsal como in therapia rotational. Iste roentgenogramma, le laminogramma transverse axial, provide informationes non solmente con respecto al contorno del corpore sed etiam con respecto al exacte location e dimension del lesion a tractar. Illo rende possibile le accurate positionamento del patiente con le lesion al centro de rotation. Illo permitte le calculation del dimension del campo a irradiar al profundor del lesion e del magnitude del dose de profundor.

WORK IN PROGRESS: RADIOLOGIC DIAGNOSIS

The final sessions of the Forty-fifth Annual Meeting of the Radiological Society of North America were given over to brief accounts of new projects in diagnosis and therapy still in the preliminary stages. Following the plan adopted several years ago for the reporting of current work in the field of radiologic physics, these papers are being presented under the heading Work In Progress.

Perforated Viscus in Infants: A New Roentgen Sign[1]

ROSCOE E. MILLER, M.D.

Spontaneous nontraumatic rupture of the intestinal tract during the first few hours or days of life is an unusual, rather perplexing condition with a grave prognosis. The perforation most frequently involves the stomach wall, but occasionally occurs in the duodenum or colon.

The usual entity, *perforation of the stomach*, is more common in boys and is often associated with prematurity or other congenital anomalies. The perforation is generally due to a congenital defect in the musculature of the stomach. Peptic ulcer, distal obstruction, trauma (especially that from the passage of tubes or the administration of oxygen), and other known causes of gastric perforation also occur in the newborn.

Of 38 cases in which the site of perforation was reported, 25 were on the greater curvature, 5 on the lesser curvature, 4 on the anterior wall, 2 in the cardia, and 1 each in the fundus and posterior gastric wall.

Clinically, the general picture in practically every instance is one of a baby perfectly well until four or five days after birth, when emesis occurs, followed by distention, then usually dyspnea, and sometimes cyanosis.

Upon x-ray examination there is positive evidence of free air in the peritoneal cavity. In most instances the distention is thought to be due to bowel obstruction and, while supine films are usually made, frequently no upright films are taken and the diagnosis is missed.

In 1950, both Leger and his group (5) and Ross, Hill and Haas (9) reported successful repair of gastric perforations in the newborn, their patients being the first to survive. In 1959, Linkner and Benson (6) reported 17 survivals after perforation of the stomach, a survival rate slightly over 46 per cent.

Perforation of the duodenum occurs in children of all ages but predominantly in infants. It has been attributed almost uniformly to peptic ulcer. It is believed that circulatory difficulty, especially in prolonged labor, tends to devitalize the duodenal mucosa and any damaged area is more liable to digestion by the acid gastric juices. Miller (7) has shown that a remarkably high acidity is present in the first forty-eight hours of life. More rarely, perforation of the duodenum occurs from an unrecognized surgical nick at a Ramstedt operation and from swallowed objects, such as safety pins.

The usual onset of duodenal perforation in infants is quite sudden, with acute fulminating symptoms and marked abdominal distention. A large pneumoperitoneum is present, and often only supine films are made due to the mistaken diagnosis of bowel obstruction. Again, the correct diagnosis is often missed.

Over 350 cases of peptic ulcer in infants have been recorded. In most reported cases, the discovery has been made only at autopsy, which, to quote Gross (3), "would suggest that there is room for improvement in recognizing the condition during life." Bird, Limper, and Mayer's patient is the youngest on record successfully operated upon (1). This was a Negro male, thirty-four and a half hours old, with a perforated duodenal ulcer. The child was normal and well six years later.

Small bowel perforation (other than duodenal) is usually due to "meconium ileus" and the perforation is most often sealed off by the inflammatory peritoneal reaction. Calcification is sometimes but not always visible on the radiograph. In infantile small bowel perforations pneumoperitoneum is almost always absent; in the rare case in which it does exist, it is usually small.

In *perforation of the colon* in the newborn the clinical picture is again that of a small baby who does well anywhere from one to five days after normal delivery. Again, there are emesis, refusal of feedings, and marked abdominal distention. As with other perforations, the distention is often thought to be due to bowel obstruction and usually only supine roentgenograms are taken and the diagnosis is frequently missed.

It appears somewhat remarkable that, while the perforation can occur anywhere in the colon, half of the reported cases in which the site was mentioned —10 of 20—have involved the transverse colon. Two of our cases at Indiana University occurred at that site.

Frequently the perforation of the colon is due to a muscular defect in the bowel wall, but multiple other causes have been reported. *Pseudomonas aeruginosa* was responsible for the perforation in 2 of our cases.

Fig. 1. Three-day-old male with normal forty-week gestation. Although there is slight rotation, the large oval divided superiorly by the streak of the falciform ligament is easily seen. At operation there was a 1-cm. perforation of the greater curvature. Discharged three weeks after surgery, the patient was alive and well three months later.

Fig. 2. Although the "air dome" sign is seen predominantly in infants, this patient, a four-year old male, was x-rayed to check the position of the drainage tube inserted for "ileus." Autopsy one day later showed perforation of the duodenum. The oval divided by the streak of the falciform ligament and urachus is readily seen.

Gross, in his textbook (3), lists a surgical cure of perforation of the colon in an infant.

COMMENT

Characteristically abdominal distention and a large pneumoperitoneum exist in all of these patients except those with small bowel perforations. A new roentgen sign has been found on supine films by which the characteristic pneumoperitoneum may be recognized, namely, a huge oval shadow outlining the periphery of the peritoneal cavity. In the presence of a significant amount of fluid, this shadow appears as a large bubble of gas centrally located in the abdomen, divided in its cephalad portion, along its central longitudinal axis, by a narrow streak which represents the falciform ligament. Occasionally, the caudal half is divided by a similar streak, representing the urachus (the plica umbilicalis media). The oval shadow produced by the air-filled dome of the distended abdomen has been likened in appearance to an American football. While this sign has been seen most frequently in infants, we have encountered it in a four-year-old boy with a perforated duodenal ulcer. Sometimes the outline is irregular, but the general oval shape is maintained (Figs. 1 and 2).

A review of the literature reveals reports of over 59 such infantile catastrophes in the stomach alone. One article (8) states: "It should be recorded that in the horizontal posture, the true nature of the abdominal distention could not be ascertained." Caffey in his book *Pediatric X-Ray Diagnosis* also stresses that "films and fluorographic observations made in the recumbent position revealed nothing but abdominal distention." In the light of our present observations, these statements would appear to be too conservative. In the 9 instances in which supine roentgenograms have been published, the sign is recognizable even in poor reproductions.

Confirmatory upright films may be taken, but it is unnecessary if the "air dome" sign is seen on the supine view. The "football" or "air dome" sign is pathognomonic and leads to early diagnosis and surgical intervention. The specificity of the sign is apparent from the fact that pneumoperitoneum has been recognized and diagnosed when only a portion of the "air dome" sign was present.

There are only a few even remotely similar pictures, which have not yet occurred in our material. An air-filled megacolon could possibly mimic this sign. Also theoretically possible is the extreme distention sometimes seen in volvulus of the sig-

moid or a rectus sheath gas abscess. There should be no difficulty in correct interpretation when one considers the presence of haustral markings, fecal material, and the overall pattern of the bowel loops. The characteristic oval line of the "air dome" divided by the streak of the falciform ligament is pathognomonic.

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[1] From the Department of Radiology, Indiana University School of Medicine, Indianapolis, Ind. Part of this study was done at the University of Chicago Clinics.

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Axillary Tumors as a Cause of False Mediastinal Mass Shadows on Lateral Chest Films[1]

FREDERICK J. BONTE, M.D., and MURRY D. SCHONFELD, M.D.

A 72-year-old Negro female who had been known to have lymphosarcoma for a period of two years complained of malaise and cough. She was referred for radiographic examination of the chest, which was done by the postero-anterior and left lateral 6-foot technics which are routine at Parkland Hospital. An anterior mediastinal mass was readily appreciable in both projections (Fig. 1). Superimposed upon the upper posterior portion of the surface of the surrounding axillary contents, to disappear posteriorly under the dorsal muscle groups, accounting for its radiographic appearance. The sharp anterior margin was not a result of compression against the cassette holder, for this margin was equally well delineated on both left and right lateral films.

Having become aware of the possibility of false mediastinal mass shadows originating in axillary

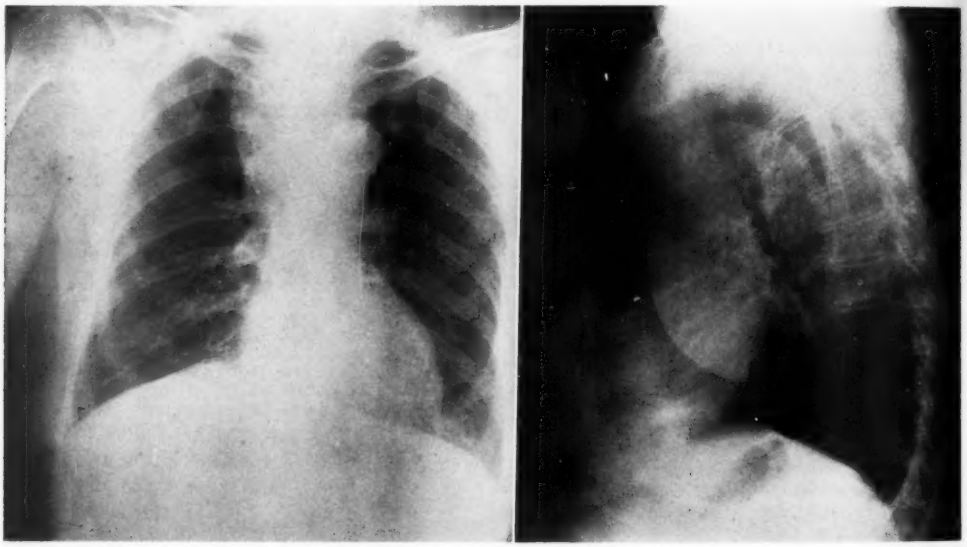

Fig. 1. Postero-anterior and left lateral roentgenograms showing anterior mediastinal mass and a curvilinear shadow superimposed upon the upper posterior cardiac silhouette.

cardiac silhouette in the lateral film was an additional density, whose curvilinear anterior margin was clearly defined though the posterior margin could not be identified.

A course of radiotherapy for a tumor dose of 2,500 rad was delivered through opposing ports to the superior mediastinum, with the result seen in Figure 2. The upper mediastinal tumor itself had resolved, but the curvilinear mass shadow, uneasily described as an artefact on the first study, was again apparent in the right lateral projection.

Physical examination disclosed a soft, pliable right axillary mass identifiable as the residual following a course of radiotherapy delivered to the right axillary lymph nodes at another hospital two years before. On inspection of the axilla with the patient positioned as for a lateral chest film, it could be seen that the anterior margin of the mass was clearly defined and projected well above the tumors, we discovered 5 additional examples during the following years and learned to distinguish the false mass shadow from a similar density which may be caused by heavy anterior axillary folds. Surprisingly, this radiographic finding seems not to have been described before, so far as we could determine on an extensive search of the literature. Additional work on the radiographic properties of the axilla is now under way, and the entire subject will be reported exhaustively at a later date.

5323 Harry Hines Boulevard
Dallas, Texas

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[1] From the Department of Radiology of the University of Texas Southwestern Medical School and Parkland Memorial Hospital, Dallas, Texas.

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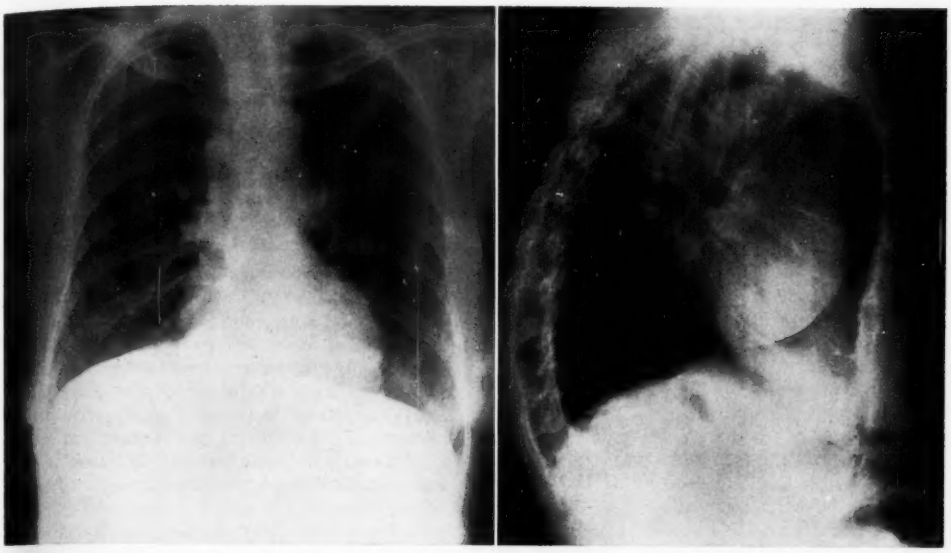

Fig. 2. Roentgenograms obtained following irradiation, showing disappearance of the mediastinal tumor but persistence of the curvilinear shadow previously demonstrated.

Comparison of the Resting Gastric Secretion of Children and Adults[1]

LAWRENCE A. DAVIS, M.D.

Examination of the gastric air bubble is a routine procedure preceding the actual introduction of opaque material into the stomach. A lengthened air-fluid interface, in the fasting patient, is generally believed to be a sign of increased gastric secretion. There is little information available as to the actual measurement of this interface in the available textbooks on gastrointestinal radiology or in the usual textbooks of gastroenterology. The apparent increase in the amount of gastric juice may be the result of enhanced secretion or possibly due to delayed emptying of the stomach secondary to an obstructive process.

I have been unable, also, to find any reference to the amount of resting gastric secretion in children as related to its appearance in the routine upper gastrointestinal tract examination. Examination of children between five and ten years of age is common in the general pediatric x-ray department, since it is during this period that the complaint of abdominal pain is frequent. It was my impression, after examining patients in this age group, that the length of the air-fluid interface in the fasting stomach was greater than that generally encountered in adults. At first, this was interpreted as a sign of increased hypersecretion secondary to possible duodenal ulceration or other gastric abnormality. In order to test this assumption, some 50 children who had been fasting were compared with a group of adults. By careful questioning of all subjects it was made certain that no fluid had been ingested and, if the results of the examination showed some obstructive disease, the patient was discarded from the series The children's group consisted of those patients coming to the x-ray department for a gastrointestinal series secondary to abdominal pain, for excretory urograms, and for heart examination. The adults were a consecutive group entering the x-ray department for upper gastrointestinal series. Spot films were made outlining the gastric air bubble in all patients preliminary to the ingestion of the opaque material. Fifty-two children with an average age of eight and a half years were examined. The air-fluid interface in this group averaged 2.6 cm. The 51 adults, whose average age was fifty-three years, showed an interface of 0.8 cm. (Fig. 1).

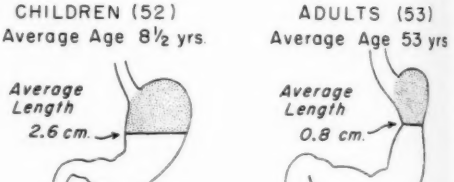

Figure 1

These findings would suggest that the average amount of resting gastric secretion in children is higher than in adults, and that its appearance cannot of itself be taken as indicative of gastric abnormality. Examination of a true "control" group of children with no gastrointestinal complaints will be undertaken to test the validity of this assumption.

226 E. Chestnut St.
Louisville 2, Ky.

[1] From the Department of Radiology, The Children's Hospital and the University of Louisville Medical School, Louisville, Ky.

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Demonstration of Blockage and Involvement of the Pelvic Lymphatic System by Tumor with Lymphangiography and Scintiscanograms[1]

ERICH K. LANG, M.D.[2]

The mode of treatment of carcinoma of the cervix is guided largely by clinical staging based on physical examination. In 1955, Graham (9) reported that 15 per cent of patients with carcinoma of the cervix, International Classification I, were found on examination of the surgical specimen to have lymph node metastases. This clearly demonstrates the need for additional methods of clinical diagnosis which will permit detection of lymph node involvement overlooked by conventional examination. Two logical approaches may be brought to bear on this problem: (*a*) direct visualization of the lymphatic system on roentgenograms by injection of a contrast medium and (*b*) indirect visualization of the lymph nodes on scintiscanograms.

Much of the pertinent data enabling us to select certain contrast media which will be transported *via* the lymphatic system have been previously compiled. The experiments of Sherman, Nolan, and Allen (11) demonstrated that radioactive colloidal gold injected into parametrial tissues reaches the regional lymph nodes, the migration taking place quite promptly. Ter-Pogossian (12) showed that the concentration of colloidal gold in the regional lymph nodes of rabbits reached a maximum six to ten hours after the parametrial injection. Flocks *et al.* (6, 7), as well as Seaman and Powers (10), reported that lymph nodes completely replaced by tumor failed to pick up any radioactive colloidal gold. These data suggest the suitability of radioactive gold for the demonstration of normal lymph nodes on scintiscanograms. Seaman and Powers, however, noted that some of the normal nodes failed to take up the gold, for reasons which were not readily apparent.

Direct visualization of the lymphatic system by lymphangiography may be used for the demonstration of tumor infiltration and even partial replacement of pelvic lymph nodes. This method, as outlined by Fuchs and his group (8), may ultimately be a useful technic, but major technical difficulties must first be overcome.

In an attempt to study the problems of lymph node visualization, patients with clinically demonstrable involvement of the nodes of the pelvis were subjected to both lymphangiography and scintiscanning after the injection of colloidal gold into the paracervical tissues. The technic employed for lymphangiography utilized the *in vivo* staining capacity of the lymphatic system for 4 per cent colloidal sky blue. The dye was usually injected into the dorsum of the foot because of its easy accessibility, and a cut-down was then performed on the dye-stained lymphatic trunks. A small cannula was inserted into the lymphatic vessels and approximately 12 c.c. of 50 per cent Hypaque was injected. Roentgenograms were obtained during and immediately after the completion of the injection. This method shows filling of the medial lymphatic trunk of the leg with the contrast substance and flow of the medium into the region of the obturator nodes as well as the iliac and para-aortic nodes.

Fig. 1. The superimposed forty-eight hour scintiscanogram shows the radioactive colloidal gold remaining in the paracervical tissues without evidence of distribution into the regional lymph nodes. The lymphangiogram shows failure of propagation of contrast medium beyond the femoral nodes. Dilatation of the lymphatic trunks is seen. Clinically, large nodular lymph node masses were palpated throughout the true pelvis.

Scintiscanograms were obtained on all patients: 20 to 40 microcuries of radioactive colloidal gold, diluted in 1 c.c. of Wydase, was injected into the paracervical area. Scintiscanograms were obtained six, twenty-four, and forty-eight hours after injection. In some cases, a delayed scintiscanogram was obtained after seven days. A 3-inch sodium iodide (thallium-activated) crystal with a 69-hole focusing collimator was used in these studies.

An examination of the experimental data reveals gratifying agreement between the clinical findings, the lymphangiograms, and the scintiscanograms in carcinoma of the cervix of stages IC3 and IC4. The pelvic lymph nodes failed to fill with the con-

Fig. 2. The superimposed twenty-four-hour scintiscanogram shows an almost normal distribution of the colloidal gold throughout the lymph node groups in the right half of the true pelvis. Activity is also demonstrated in some of the para-aortic nodes. Note the failure of symmetrical distribution of radioactivity throughout the left half of the true pelvis and its lymph node groups. There is also a significant absence of radioactivity in the presacral nodes. The lymphangiogram demonstrates failure of propagation of the contras medium beyond the obturator nodes on the left side. Clinically, there was a large nodular mass occupying the left half of the true pelvis.

trast medium on lymphangiography. The routine six, twenty-four, and forty-eight hour scintiscanograms, as well as studies obtained as long as one week after the injection, showed concentration of the radioactive material at the injection site and failure of its normal distribution into the regional and para-aortic nodes. Spurious radioactivity was found in some of the lymph nodes only partly replaced by tumor. A radioautograph of one of the operative specimens showed the radioactivity to be limited to the remaining normal lymphoid tissue. In general, however, only minimal uptake of the radioactive colloidal gold was recorded in nodes partly replaced by neoplastic tissue.

A second group of patients with a clinical diagnosis of carcinoma of the cervix, stage IC0, was examined in the same manner. Unfortunately, in this group there often were striking discrepancies between the surgical-pathological findings and the scintiscanograms. Approximately 25 per cent of the cases examined failed to show a normal distribution of radioactive colloidal gold to the lymph node groups, suggesting the possibility of replacement of some of the nodes by tumor tissue. The surgical-pathological specimen, however, failed to reveal any tumor invasion. In at least one of the cases, there was evidence of inflammatory disease of the group of nodes which failed to concentrate the colloidal gold. In some instances, however, completely normal lymph nodes failed to concentrate colloidal gold, for reasons which are not apparent to us. This unpredictability of concentration of the isotope in normal nodes makes it quite difficult to utilize this method to predict their early involvement or partial replacement by tumor.

Lymphangiography appeared to be a more reliable tool in these cases and in no instance gave a so-called "false-positive" result. The definition of lymph nodes, however, particularly in the true pelvis, was rather poor. This was perhaps due to the contrast medium used in this study. At least, experiments conducted on dogs with Thorotrast have provided excellent visualization of the lymph nodes. Also, Collette (4), using a colloidal contrast medium, was able to demonstrate partial tumor replacement of lymph nodes in the true pelvis. Fischer (5) and Barer (2) using similar media were able to demonstrate lymph node structures in excellent detail. Such results in man, however, must await the development of a nontoxic contrast medium with radiologic characteristics similar to Thorotrast.

In spite of the fact that there appears to be greater accuracy in the diagnosis of lymph node involvement by lymphangiography than by scintiscanograms, the latter method, we believe, should not be abandoned. Modifications of the technic, including the use of multiple injection sites, will perhaps decrease the number of "false positives." There also appears to be a correlation between the amount of material injected and the free distribution throughout the lymphatic system. A new group of patients is now being investigated with scintiscanograms in order to evaluate a number of changes in the technical procedure. From preliminary results, it appears that there may be a significant decrease in the number of "false positives" with a technic utilizing multiple injections in the parametrial and paracervical areas.

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[2] Instructor in Radiology, The Johns Hopkins University and Hospital, Baltimore, Md.

Effect of AET and MEG on Rat Thyroid I^{131} Uptake[1]

M. S. POTSAID, M.D., and YOSH MARUYAMA, M.D.

The chemical radioprotective agent, AET (S, 2b-Aminoethylisothiuronium·Br·HBr), becomes MEG (2-Mercaptoethylguanidine) (Fig. 1) at *p*H 7 (1). Since these preparations chemically resemble antithyroid compounds, it is important to determine whether some of their protective action may be mediated through the thyroid gland. This is a report on the effect of AET and MEG on radioactive iodine uptake.

TABLE I: EFFECT OF AET ON THYROID I^{131} UPTAKE (0.5 μc I^{131}; 300 mg./kg. AET)

Hours After Injection of I^{131}	Group*	Per Cent Administered I^{131} in Thyroid Gland	Per Cent of Controls
2	Control (8)	8.9±3.9†	100
2	AET (8)	0.9±0.2	10
4	Control (7)	26.2±5.1	100
4	AET (8)	2.9±1.6	11
6	Control (8)	36.1±6.5	100
6	AET (8)	8.2±1.6	23
24	Control (8)	42.2±7.2	100
24	AET (8)	31.9±4.0	76

* Figure in parentheses indicates number of animals in group.
† Standard deviation.

TABLE II: EFFECT OF MEG ON THYROID I^{131} UPTAKE (0.5 μc I^{131}; 250 mg./kg. MEG)

Hours After Injection of I^{131}	Group*	Per Cent Administered I^{131} in Thyroid Gland	Per Cent of Controls
4	Control (6)	18.5±4.9†	100
4	MEG (7)	1.41±0.5	8
6	Control (8)	36.1±6.5	100
6	MEG (8)	12.2±2.8	35
24	Control (7)	42.0±8.0	100
24	MEG (7)	26.5±2.5	63

* Figure in parentheses indicates number of animals in group.
† Standard deviation.

Materials and Methods: One hundred and sixty-seven Sprague-Dawley male rats weighing 90 to 190 gm. were fed a Remington diet for five days prior to the experiments. Freshly prepared AET or MEG was injected intraperitoneally, followed in thirty minutes by an intraperitoneal injection of 0.5 or 1.0 microcurie of carrier-free I^{131} as iodide. At two, four, six, and twenty-four hours after the injection of AET or MEG the animals were sacrificed and the thyroid glands were removed and individually counted in a well-type scintillation counter to measure radioactive iodine uptake.

The effect of dose variation was studied with both AET and MEG. Thirty minutes following the intraperitoneal administration of the above compounds, 1 microcurie of I^{131} was administered and the thyroid uptake measured after four hours.

TABLE III: EFFECT OF AET DOSE VARIATION ON I^{131} UPTAKE

mg./kg. AET	Hours After Administration of I^{131}	No. Rats	Per Cent Administered I^{131} in Thyroid Gland	Per Cent of Controls
0	4	5	24.9±5.7*	100
100	4	6	16.9±56	63
150	4	6	9.2±3.8	33
200	4	6	5.9±3.2	22
300	4	8	2.9±1.6	11

* Standard deviation.

Results: Administration of AET profoundly depressed the uptake of I^{131} by the thyroid (Table I; Fig. 2). This effect was noted soon after the injection of AET, but by twenty-four hours the experimental group recovered to 76 per cent of the controls. MEG showed a similar response (Table II; Fig. 2).

Table III and Figure 3 summarize the effect with varying doses of AET four hours after injection. MEG exerted a similar depression of I^{131} uptake by the thyroid (Table IV).

TABLE IV: EFFECT OF MEG DOSE VARIATION ON I^{131} UPTAKE

mg./kg. MEG	Hours After Administration of I^{131}	No. Rats	Per Cent Administered I^{131} in Thyroid Gland	Per Cent of Controls
0	4	6	19.2±4.9*	100
100	4	6	16.6±3.1	85
150	4	6	11.4±5.8	59
200	4	6	7.5±2.5	39
250	4	6	1.4±0.5	8

* Standard deviation.

DISCUSSION

The protection of mice by AET and MEG against lethal doses of whole-body x-irradiation has been well shown (2). AET and MEG have been postulated to form resonance stabilized radicals that "trap" free radicals which presumably cause radiation damage at the cellular level.

Whether this is the entire explanation is not yet clear. Our preliminary studies following the administration of these compounds show a profound depression of the radioactive iodine uptake

S,2-AMINOETHYLISOTHIURONIUM·Br·HBr

AET

2-MERCAPTOETHYLGUANIDINE·HBr

MEG

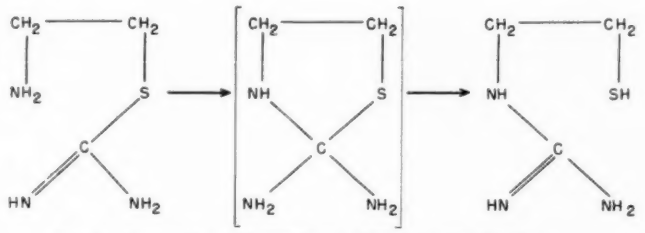

Fig. 1. Formation of MEG from AET by neutralization.

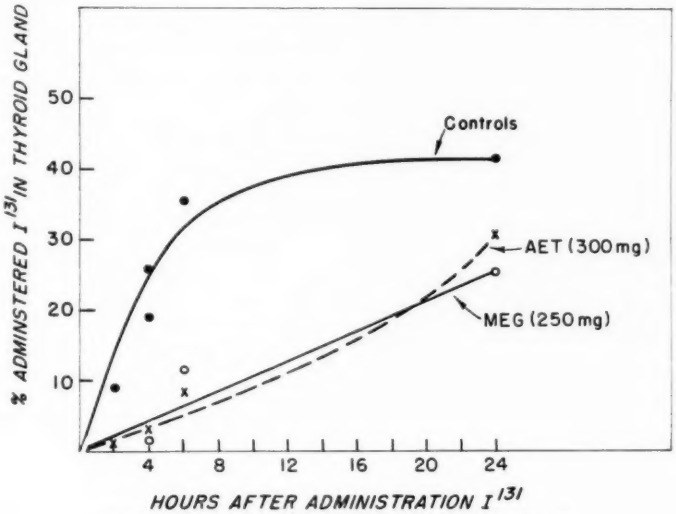

Fig. 2. Effect of AET, MEG and time on I^{131} uptake.

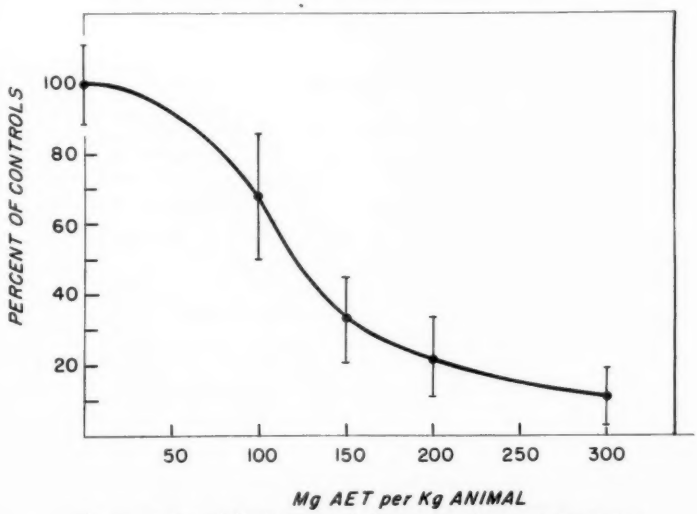

Fig. 3. Effect of AET dose variation on four-hour uptake of I^{131}.

Whether the mechanism of this depression is antithyroidal or extrathyroidal is still under evaluation. The increased sensitivity of the hyperthyroid animal to radiation is well established (3, 4), and there has been evidence that the hypometabolic animal (5) or anoxic animal (6) is less sensitive to the effects of x-irradiation. As the hypothyroid animal metabolizes more slowly and has a lower oxygen utilization, the possibility of a thyroid mechanism contributing to radioprotection is attractive, and is under investigation.

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On Increasing the Versatility of Specialized Equipment[1]

RUSSELL WIGH, M.D.

The expanding scope of investigations in diagnostic roentgenology requires increasingly greater space and more specific equipment to meet specialized requirements. In many departments, neither the need of space nor the financial demands can easily be met. As a consequence, perhaps one should take inventory of what he has and try to learn whether modifications of installed equipment may not serve as adequately as would additional units fit only for individual tasks; or, if purchases are to be made, consideration might be given to equipment with multipurpose capacity.

This communication will outline briefly how one can add to existing specialized equipment, to increase its usefulness, at but moderate expense. Subsequent publications will deal more adequately with a master control for the involved circuitry, designs, and details of application. Essentially, it will be shown how a biplane roll-film changer manufactured primarily for angiocardiography has been adapted so that it is easily usable also for biplane cerebral angiography; how one can use the basic changer for aorto-arteriography by a patient-propulsion technic with minimal additional cost; how this same principle may be employed for other "long-film" studies, such as venography; and how to incorporate dynapulse timing into conventional work in the same radiographic room. Since film changers have long been used for splenoportography or other serial studies of a single area, as in serial nephrography, no further mention of these procedures will be made.

Our initial investment was the addition of a biplane roll-film changer and two dynapulse timers to a fluoroscopic-radiographic room of moderate dimensions. This room contains a ceiling-crane tube mount.

It was evident from the external construction of a biplane Elema roll-film changer that it was not readily applicable to simultaneous two-plane cerebral angiography, since the equipment as delivered had one attached and immovable tube mount. If one selects this mount for angiocardiography it permits exact alignment of the beam over the horizontal roll of film. Thereafter, however, one has no means of angling this central ray for other studies. A curved metal plate has been added to the original mounting stem which permits a heavy-duty x-ray tube to travel through a 50° arc. This guide plate allows up to 25° angulation for the anteroposterior projection of the skull. The design of this new mounting and considerations concerning positioning technic will be discussed elsewhere (1). Figure 1 demonstrates the arched steel plate with the tube in position for an angled projection.

The versatility of the room and of the equipment is markedly increased by a circuitry which will allow dynapulse timing or impulse timing to either tube

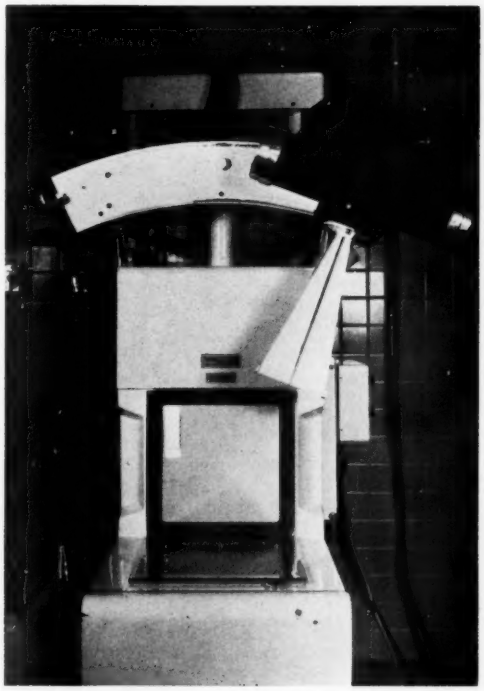

Fig. 1. Biplane roll-film changer. There has been added to the original tube mount stem a metal guiding plate which permits up to 25° angulation of the central ray.

alone, dynapulse exposures with the rapid film changer, conventional exposures with the rapid film changer, dynapulse or conventional exposures with the general radiographic equipment, and a combination of ordinary timing and dynapulse timing in different planes with the biplane roll-film changer. A control system to facilitate the use of these various combinations has been designed (2). Subsequently, with the flexibility obtained by this system, other uses of the film changer and of dynapulse exposures could be more readily investigated. A study is in progress evaluating the reduction in patient exposure with such constant-potential radiography.

We wished to have suitable equipment for examination of great lengths of the vascular system and particularly to be able to visualize in continuity the abdominal aorta and the vascular tree of both lower extremities. It was desired to know whether the basic equipment in this special room could fulfill the requirements with a minimum of expense.

The method selected required that the patient be moved over the film exposure area of one plane of the changer. The rolling table top used for angiocar-

Fig. 2. A single frame from an aorto-arteriographic sequence of films obtained with patient propulsion. This exposure was made twenty-five seconds from the time the aortic injection was begun. The table was then moving in reverse direction. The right popliteal artery was not filled at fifteen seconds, nor was the left superficial femoral artery to the point demonstrated. On both sides erroneous conclusions might have been drawn concerning the points of occlusion had the table travel not been reversed to obtain delayed films.

diography was converted into a motorized one, the speed of motion being controlled by a variable voltage adjustor. Initially, in order to exclude the need of stopping the propulsion of the patient for each exposure, the x-ray tube was energized through the dynapulse unit to obtain the advantage of a very short exposure time. Through some experiments, however, it was found that, up to table-top speeds of 3 inches per second, an exposure of 1/60 second produced no perceptible blurring of the image of the opaque bolus. As a consequence, conventional timing can be employed, since a technic can be worked out for this rate of movement.

At the present time, we are moving the patient at a rate of 3 inches every second and are making 1/60 second exposures at two-second intervals. Actually, the exposures and the movement of the patient are not started until a portion of the opaque medium is introduced. When the ankles move under the x-ray tube, the motor is reversed, so that delayed filming is accomplished. Figure 2 illustrates delayed filling of a portion of the right popliteal artery as well as an occlusion at its midpoint; it also demonstrates occlusion of the left superficial femoral artery. This exposure was made twenty-five seconds from the beginning of the injection; the table was traveling backward. On an earlier frame, at fifteen seconds, the distal right superficial femoral artery had *appeared* to be occluded, as well as the left superficial femoral artery in a more proximal region. Without reverse propulsion this false conclusion would have been drawn. Construction details, experimental data concerning table motion and exposure time, considerations relating to patient weight versus transportation speed, and data relating to wedges to compensate for variations in body-part thickness are considered separately (3).

We have to date not recorded the venous return system after aortic injection. We believe that this will be feasible for research procedures but probably not necessary on a clinical basis. There seem to be very few applications. It is probable that an intact arterial system will be essential.

The venous system can be studied separately, the initial travel direction of the table simply being reversed.

We believe that we will find a propulsion technic preferable also for unilateral femoral arteriography in those circumstances when bilateral study of the extremities, either with or without abdominal aortic examination, is not essential (*i.e.*, postoperative arterial grafts).

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[1] From the Department of Radiology, Medical College of Georgia, Augusta, Ga.

Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

A Cardiovascular Injector[1]

K. AMPLATZ, M.D.[2]

The use of peripheral angiography and selective angiocardiography has rapidly increased during the past few years. For the injection of contrast medium through a cardiac catheter, high pressures are needed, making the use of a power injector mandatory. Peripheral angiography and also cerebral angiography can be satisfactorily performed by hand, but with considerable radiation hazard to the operator if done repeatedly. Controlled pressure, exact timing, and protection from radiation can be achieved by means of a simple, automatic syringe.

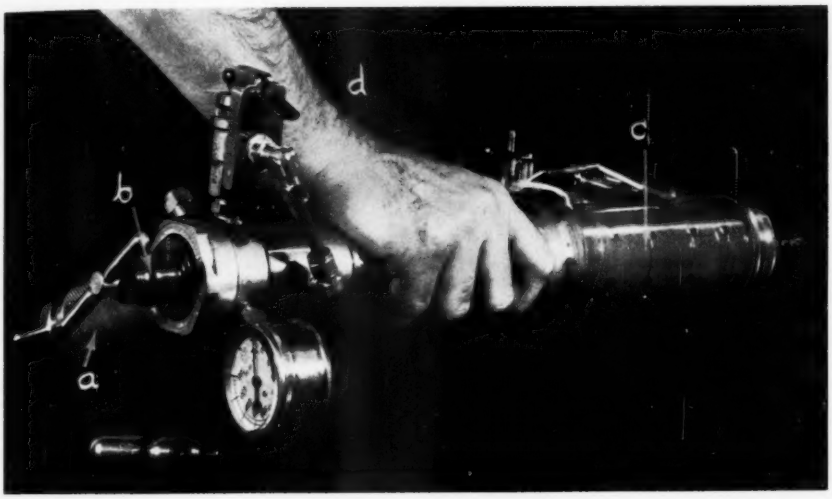

Figure 1

Commercially available manually-operated injectors do not deliver the high pressures required for selective cardioangiography, and the operator is exposed to secondary radiation during the time of injection. The rather expensive automatic power injectors are usually employed only for selective cardioangiography, since they are large, complicated machines which cannot be easily adapted for peripheral angiographic work. We have attempted to bridge this gap in available equipment by designing and constructing a simple portable injector suitable both for peripheral and cardioangiographic studies.

In this power injector, as in almost all of the others, compressed gas is used to activate the piston in the pressure cylinder. Our inexpensive source of power is a carbon dioxide cartridge, of the type which is generally carried by drug stores for the preparation of charged water. These cartridges contain a fairly large amount of carbon dioxide under a pressure of approximately 750 pounds per square inch, depending on the room temperature.

For operation of the injector, one cartridge is placed in the cartridge holder as shown in Figure 1(*a*) and perforated by the puncture needle. The desired pressure is selected and set by the reducing valve (*b*), which is directly mounted to the pressure cylinder. The force is then transmitted to the syringe at a power factor of 1.45. Since glass syringes do not withstand the required high pres-

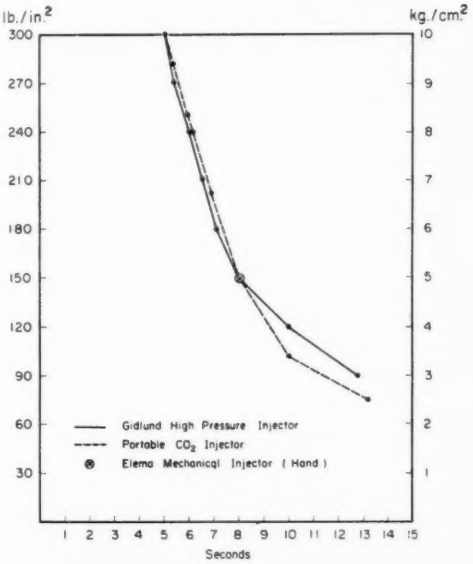

Figure 2

sures, a stainless steel syringe was constructed with a total capacity of 90 c.c. Perfect sealing of the piston is achieved by use of physiologically inert silicone-rubber piston rings, resulting in low internal friction.

The syringe, after it has been loaded and the air has been expelled, as in the conventional glass syringe, is placed in the injector, which is kept at constant body temperature by a heating jacket (*c*) and thermoswitch. By depression of the three-way valve (*d*), the contrast medium is ejected; the stroke in the pressure cylinder is adjusted so that 20 c.c. of contrast medium remains in the syringe as a safety precaution against any possible injection of air. The x-ray exposure is triggered automatically by setting a spacer on the calibrated piston rod and can be started anywhere from the very beginning to the end of the injection period.

We have compared this injection apparatus with the Gidlund high-pressure syringe and the manually-operated Elema injector, which are the most widely used injection equipment. Seventy cubic centimeters was injected through a wide-lumen No. 6 catheter and injection time was plotted at different pressures (Fig. 2). It is apparent that the injection time with the manually operated injector is considerably longer than with the two power injectors which deliver the same amount of fluid per unit time.

Some of the advantages of this apparatus are: (1) simple design, (2) a cheap, readily available power source (CO_2 cartridges), (3) pressure control ranging from very low pressures comparable to a slow hand injection up to high pressures required for selective cardioangiography, (4) possible placement of the injector on the x-ray table beside the patient, allowing the use of shorter catheters with lower resistance, (5) adaptability to every type of angiographic work.

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[1] Made by C. H. Christian-Kotula, 2741 Kyle Ave., Minneapolis 22, Minn.

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[2] Instructor, Department of Radiology, University Hospitals, University of Minnesota, Minneapolis, Minn.

Technical Considerations of Selective Arteriography[1]

COLVIN H. AGNEW, M.D.,[2] ROBERT N. COOLEY, M.D., JOHN DERRICK, M.D., LUCAS BEENTJEES, Ph.D.

Elective visualization of branches of the aorta can be obtained by injecting contrast substance through a catheter placed in or near the selected artery. We began our experimental work with available intracardiac catheters. Using dogs, we promptly convinced ourselves that success hinges upon fluoroscopic visualization of a catheter tip having the proper curve. Moulded radiopaque catheters met these requirements.

Fig. 1. A. The catheter has the proper gentle bend to enter the ipsilateral renal artery.
B. The catheter has an S-shaped curve for introduction into the contralateral renal artery. The tip lies in the stump of the right renal artery. There is an arteriovenous fistula, with contrast material entering the bulbous renal vein and dilated inferior vena cava.

Preparation of Catheter: Catheter design needs to be individualized. Disposable catheters (KIFA) may be bent, punched, and sealed to meet the anticipated needs (4). The proper bend is obtained by heating the catheter containing the stylet over a steam bath (176° F.) and cooling in running water while maintaining the arc. Slight heating of the adaptor end will cause it to curl, facilitating the development of the collar. The flanging tool will finish the seat for the Luer-Lok adaptor. Sterilization may be accomplished by immersion in germicidal solutions or fumigation at 140° F. for three hours in ethylene oxide.

Before the introduction of the catheter it should be thoroughly irrigated with sterile saline as well as rinsed externally. Lubrication with sterile mineral oil may facilitate its passage.

Introduction of Catheter: The essential features for open exposure were developed by one of us (J. D.) following the observation that large needle punctures of arteries produced complications. Ödman's (2) report of 58 per cent incidence of minor complications with the percutaneous femoral route reinforced our determination to continue this method. The artery is exposed under local anesthesia and the adventitia stripped. Umbilical tape is looped about the vessel above and below the site for introduction of the catheter to regulate bleeding. It is important to exclude collaterals. The distal artery is injected with 0.2 per cent heparin solution. A short transverse incision is then made in the artery, the proximal tape is loosened, and the catheter containing the stainless steel stylet is advanced gently to the approximate origin of the desired vessel. With removal of the stylet, the curve at the tip is largely restored. A 30-c.c. syringe containing normal saline with 0.2 per cent heparin is attached to the catheter. It is usually fairly easy to control the bent tip with external rotation and to visualize fluoroscopically entry into the selected vessel. During injection the tip should not be in the artery. When the catheter is removed, continuous suction is maintained to insure removal of any tiny clots. The artery is repaired with 6-0 arterial silk.

Visualization of Vertebral and Carotid Arteries: The catheter may be introduced through the brachial artery and placed near the origin of the vertebral and common carotid so that visualization of these vessels is distinct. Fluoroscopic control of the catheter is highly recommended. The arch of the aorta may be approached from the femoral artery, but this requires a considerably longer catheter, which reduces the flow rate.

Visualization of Renal Arteries: The proper curve to enter each renal artery is critical. To enter the contralateral renal artery, it is necessary to use an S-shaped catheter (Fig. 1, B). However, to enter

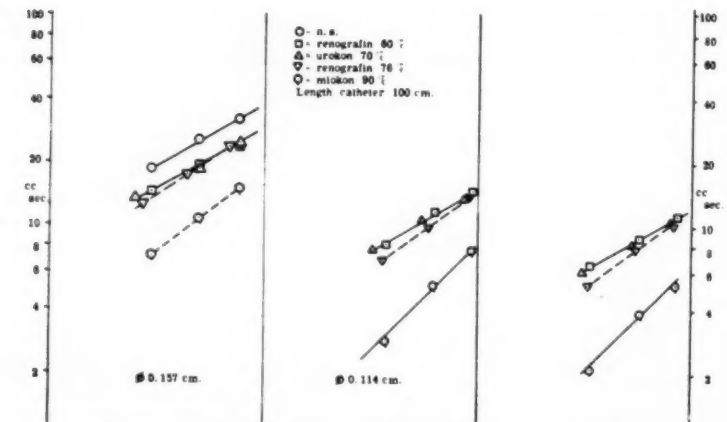

Fig. 2. A. Log-log graphs showing the quantity of various contrast substances (c.c./sec.) for various pressures. The diameter of the yellow catheter is 0.157 cm., the green catheter 0.114 cm.; the diameter of the red catheter was not determined.

B. The data have been expressed as iodine delivered (grams per second) in various pressures through these same catheters. The dashed lines are presumed to represent a switch from laminar to turbulent flow.

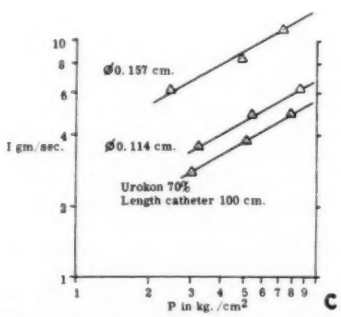

Fig. 2. C. Detail of Urokon 70 per cent for three catheters.

the ipsilateral renal artery the catheter needs to be gently curved in its major portion with a slightly bent tip (Fig. 1, A). One should take pains to withdraw the catheter to the renal artery origin before injection. Plaques can easily be overlooked and unnecessary arterial spasm may be promoted.

Visualization of Celiac and Superior Mesenteric Artery: Successful entry into the superior mesenteric artery may be accomplished in the supine position; identification is more positive, however, in the oblique and lateral positions.

Flow Rates: The factors which may be altered to increase the flow rate (c.c. per second) include pressure, diameter, viscosity (length and shape of catheter being constant). Our experimental data on flow rate was obtained by the use of different commercial preparations. The Gidlund (1) pump was preset for different injection pressures. The pressure was determined by the gauge on the pump, and 50 c.c. volume of solution was injected as measured on the pump. The solutions were preheated and placed in the injection syringe (37° C). and introduced through a catheter into a bottle at atmospheric pressure.

Rodríguez-Alvarez (3) has stated that "there is not any important variation in the flow rate when injecting against a mercury column of 200 mm." Ödman compared various concentrations (45, 60, and 76 per cent) of Renografin to normal saline through the radiopaque polyethylene catheter and a three-ribbed catheter. Our data have been calculated for a 100-cm. radiopaque catheter, and with our yellow catheter (0.157 cm. diameter) we appear to approach quite close to his results (Fig. 2, A).

When iodine (grams per second) is plotted against pressure, Urokon has the highest flow rate with the temperature and catheter size we employed (Fig. 2, B). Hope has been expressed that higher iodine-containing contrast substance would enhance radiological procedures. It should be emphasized that in our hands 90 per cent Miokon does not deliver any more iodine per second than does 76 per cent Renografin.

Flow characteristics in small caliber vessels are difficult to analyze. Poiseuille's law (1843) gives the relation between pressure and outflow for *laminar* flow. Blasius derived from experiment such a relation for their *turbulent* region. These differences are reflected in the different slopes of the graphs (solid lines). Since only three points have been measured, we did not attempt to analyze the intermediate case, but have drawn broken lines instead of solid ones through them without claiming that this will represent the actual behavior. These steeper (dashed) lines are presumed to represent a switch from laminar to turbulent flow."

Design of the catheter tip is still under investigation. All of our clinical studies have been done with an end-hole catheter. In selective arterial injection, however, a combination of an end hole and side hole may possibly be better.

Contrast Substances: Hypaque 50 per cent and Renografin 60 per cent are well tolerated by the conscious patient. Although Urokon 70 per cent has a significantly higher flow rate we believe that the discomfort attending its use overshadows the gain in flow rate. Five cubic centimeters is sufficient to demonstrate many vessels; 12 c.c. in adults has proved more than adequate for abdominal arteriography.

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[1] From the University of Texas Medical Branch, Department of Radiology (R. N. C. and L. B) and Department of Surgery (J. D.) Galveston, Texas.

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[2] Present address: Department of Radiology. Kansas University Medical Center, Kansas City, Kans.

Combined Intraluminal Esophageal Pressure Studies with Synchronous Cinefluorography[1]

THEODORE A. TRISTAN, M.D.,[2] HERBERT J. KOERNER, M.D.,[3] and JAMES S. WATSON, Jr., M.D.[4]

Improved surgical and anesthetic technics permit removal or correction of esophageal lesions by thoracotomy in an increasing number of patients. For this reason, more precise anatomic and physiologic diagnosis is required. Since criteria for the roentgen diagnosis of hiatal herniation are disputed, and because the clinical significance of minimal to moderate degrees of herniation is often uncertain, a study was undertaken to evolve more specific criteria. A second objective was to evaluate these criteria by applying them to groups of patients in different age groups and over long periods of time.

Initially, 300 cinefluorograms of the distal esophagus were reviewed. These were classified in three groups: (*a*) normal, (*b*) hiatal herniation, (*c*) other lesions. These interpretations were compared with the clinical histories of the patients and correlation between the roentgen diagnosis and the clinical impression was found to be poor. A restudy of the same group of cinefluorograms showed considerable intra- and inter-personal variation in the grouping of the patients. The experience and familiarity of the observer with the cinefluorographic method, the skill of the cinefluorographer in making the examination, and variation in the methods used to demonstrate hiatal herniation were uncontrolled variables. In addition, the patients examined cinefluorographically were chosen for reasons of availability; that is, many were examined because of clinical suspicion of hiatal herniation or because a hernia was suspected or observed during routine gastrointestinal examination.

This preliminary investigation suggested that the establishment of better criteria for the diagnosis of hiatal herniation and judgment of its clinical significance in the individual case might well be impossible by radiological methods. It was felt, however, that additional studies should be carried out before a negative attitude was adopted.

It was evident that normal esophageal mechanics and motility as related to the cinefluorographic appearance of the esophagus were not well understood. A study of the literature served only to supply a confusing nomenclature. In studies published by physiologists, principally those by Code *et al.* of the Mayo Clinic (1, 2), the presence of an intrinsic sphincter separating the esophagus from the stomach in the resting stage was conclusively demonstrated by intraluminal pressure-recording methods. The fluoroscopist, however, examines his patient while more active maneuvers are being carried out, and the localization of a sphincter mechanism during swallowing and certain phases of respiration is difficult.

Synchronously recorded cinefluorograms and intraluminal pressure studies were therefore attempted.

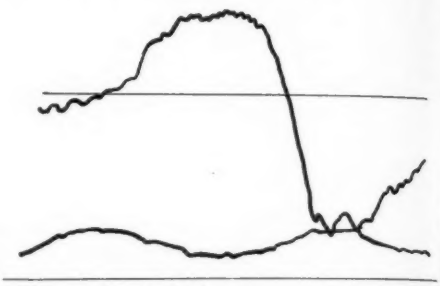

Fig. 1. Intraluminal pressure record. Thin horizontal lines are base lines. The lower thick line is the respiratory curve; the upper thick line the intraluminal pressure variation. The intragastric portion of the latter curve is at the left; the lower intraesophageal pressure is at the right. The slight elevation in the center part of the curve represents the increase in pressure over intragastric pressure, recorded as the tip of the pick-up device passes through the distal esophageal sphincter.

The patient swallows a small polyethylene catheter filled with water, the meniscus at the tip of the tube acting as the pressure-sensitive pick-up device. Recording of pressure variations is carried out by means of transducers on an electronic channel recorder. A photographic paper record of the intraluminal pressure variation, the respiratory cycle, and the electrocardiogram is obtained, monitored during the procedure on an oscilloscope. Cinefluorographic records are made simultaneously and synchronously. The activity of the barium-filled esophagus is recorded under varying conditions, that is, with the patient in the erect, supine, and prone positions, holding his breath, swallowing, breathing normally, or performing the Valsalva maneuver.

A group of 60 healthy volunteers were examined to gain experience in obtaining pressure records (Fig. 1). A resting high sphincter pressure was consistently demonstrated in most of the tracings. No cinefluorograms were made of these subjects, however, since they were all young adults. About 25 studies have been performed in older patients with the combined method, and the cinefluorograms and pressure records have been carefully compared. Some of these patients had hernias and some did not. In this initial group, several points of interest have been noted.

Almost without exception, in patients both with and without hiatal herniation, the point of pressure reversal occurs in an area proximal to the hiatus of the diaphragm. One might anticipate that such a pressure change would occur at the level of the hiatus in a normal subject. Apparently, then, the area of distal esophageal sphincter activity in normal individuals is localized more proximally than

first suspected (Fig. 2). These preliminary observations confirm those of Johnstone (3), based on fluoroscopy and on roentgenograms.

The appearance of a shelf, notch, or ring-like indentation in the border of the distal esophagus commonly and inappropriately termed "Schatzki's ring," was observed not only in these 25 cases but also in the preliminary study of 300 cinefluorograms

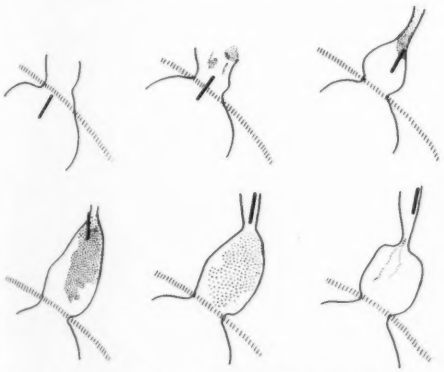

Fig. 2. Tracings of individual frames of a cinefluorogram of the distal esophagus at which time simultaneous intraluminal pressure recording was obtained. The pick-up device is in the stomach, upper left, and is slowly withdrawn into the distal esophagus, upper center, upper right. An increase in pressure above intragastric levels was noted in the frames at upper right, lower left, and lower center. Negative intrathoracic pressure levels were recorded when the tip reached a definite intraesophageal location, lower right.

previously mentioned. It is our feeling that this indentation is so commonly observed and demonstrated cinefluorographically that it is a normal structure. These notches or rings are often visualized in a transient and incomplete form and are frequently undetected at routine fluoroscopy.

Unless the structure observed meets the specific criteria described by Schatzki and Gary (4, 5), it should be considered a normal finding. Most of the rings observed cinefluorographically and at routine fluoroscopy do not meet these criteria (Fig. 3).

Visualization of a ring or a small pouch above the hemidiaphragm that appears to contain gastric mucosa and has a notch or ring in the margin of the esophagus has been advocated as *the* diagnostic criterion of a hiatal herniation (6). The present studies arouse considerable doubt in our minds as to the reliability of this sign. Further detailed studies concerning the location of the ring above the hemidiaphragm, its character and its variations, must be performed.

The roentgen diagnosis of a hiatal herniation is of little value unless it indicates that the lesion is of clinical significance in a certain group of cases and not in others, which may have a superficial resemblance. Further examinations of the esophagus will be made by combined intraluminal pressure recordl

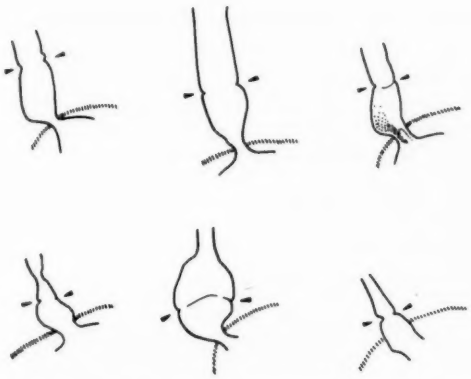

Fig. 3. Tracings of pertinent frames from six distal esophageal cinefluorograms. The arrows marking the esophagus in each frame locate the notch or indentation in the border of the distal esophagus in these patients. The indentation varies in size from almost imperceptible to pronounced, but none of these changes can be termed a "Schatzki's ring."

ing and synchronous cinefluorography in patients coming for gastrointestinal examination, and, when additional criteria are observed, they will be compared with the clinical course in the individual cases.

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[2] Assistant Professor of Radiology, School of Medicine and Graduate School of Medicine, University of Pennsylvania.

[3] Instructor in Radiology, University of Rochester, School of Medicine and Dentistry, Rochester, N. Y.

[4] Research Professor of Radiology and Consultant in Medicine, University of Rochester, School of Medicine and Dentistry.

Yttrium-90 Transnasal Hypophysectomy: Technic and Dosimetry[1]

JOSEPH L. WESTOVER, M.D., ROBERT W. RAND, M.D., and MOSES A. GREENFIELD, Ph.D.

Hypophysectomy is an accepted procedure for palliation in metastatic carcinoma of the breast. In several series reported, however, the incidence of complications due to the procedure has been high. A modified technic for transnasal yttrium-90 hypophysectomy has been developed in an effort to minimize complications and reduce irradiation exposure to the operators.

Dosimetry studies indicated that precise placement of the radioactive sources is necessary, not only to destroy the anterior lobe of the pituitary but to avoid visual complications secondary to over-irradiation of the optic nerves. The film-pack dosimetry method of Freitag *et al.* (1) for beta emitters is employed. Two clumps containing six yttrium-90 beads each are arranged with their centers 6 mm. apart—a geometric arrangement considered to be ideal for pituitary ablation. A pack of Dupont 555 dosimetry film is prepared with paper spacers so that readings can be obtained at intervals of 1.0 mm. from zero to ten. The pack is placed on the beads for a predetermined time. After development, the films are read on a photovolt transmission densitometer and dose values are calculated. When twelve beads were used, with a total activity of 14.4 mc, films from zero to 3 mm. were too dark to read. At 4 mm., the calculated dose to decay is approximately 100,000 rep; at 7.5 mm., 10,000 rep; at 10 mm. 1,000 rep. The dark area on the films also reveals the pattern of the dose curve in anteroposterior and lateral dimensions.

Fig. 1. Rand-Wells stereotaxic device in use. A radioactive bead is being inserted.

There is much variation in size and shape of the sella turcica and in the location of the optic chiasm. James Bull (2) has shown the normal variations in position of the optic recess of the third ventricle, which he designates as the "chiasmatic point." Because of the many variables, he introduced the "nasion-tuberculum" plane—a line drawn from the tuberculum sella back to the posterior clinoid, parallel to the floor of the sella—as a reference for measurement. Measuring the height of the optic recess above the plane in 117 normal encephalograms, he found that the bulk of the cases fell in the 8- to 13-mm. range. In 6 cases, however, the measurement was 4 to 6 mm. In applying depth

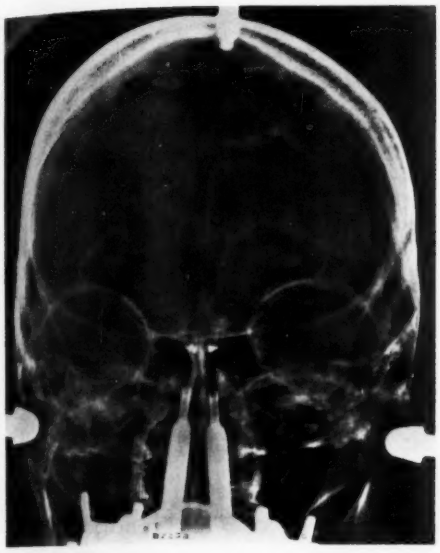

Fig. 2. Yttrium-90 beads shown in position in anteroposterior projection. Needles have been removed. Guides are still in position.

dose values to Bull's measurements, it becomes obvious that the radioactive beads must be placed well below the "nasion-tuberculum" plane. If this is done, the dose to the chiasm in most instances will be less than 1,000 rep.

We consider the stereotaxic method to be the most accurate means of placing the radioactive sources. The Rand-Wells stereotaxic device was designed to afford complete control of guides, drill, and needles. At the same time it does not interfere with the endotracheal tube for anesthesia. The patient's head is immobilized, and identical anteroposterior and lateral radiographs can be obtained. Two radiographic tubes are used. Adjustable guide holders are calibrated in degrees. When one guide is aligned, the second can be placed quickly in the same relative position. No tissue is perforated until there is perfect alignment on the sella. A drill is used to perforate the wall of the sphenoid sinus and floor of the sella. Drilling reduces trauma and lessens the possibility of rhinorrhea.

Rapid check of position and guide angles is done with polaroid film in anteroposterior and translateral projections. There is no exposure to the operators as with the fluoroscopic method. Correction of needle guide angles can be determined quickly on the film.

The radioactive beads are removed individually from the plastic shield with a specially devised forceps and dropped into a small plastic funnel which fits into the needle hub. They are pushed out of the needle with a flat-ended stylet.

The beads average 1.2 mm. in diameter and pass readily through a 16-gauge needle. At operation, the number of beads implanted varies with their activity at the time. Usually five or six beads on each side give the desired total activity of 9 to 10 mc.

Investigation is under way to devise a satisfactory method of plugging the holes in the floor of the sella, to further reduce the likelihood of rhinorrhea.

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Ureteroceles in Children, with Emphasis on the Frequency of Ectopic Ureteroceles[1]

JOHN P. DORST, M.D., GERALD H. CUSSEN, M.D., and FREDERIC N. SILVERMAN, M.D.

The most common type of ureterocele in infants and children is an intravesical and intraurethral protrusion of a dilated ureter which passes submucosally in the vesical wall before ending ectopically in the urethra. Termed an *ectopic ureterocele*, it differs significantly in pathologic anatomy from the better known *simple ureterocele*. The latter characteristically occurs in the adult and consists of an intravesical cystic expansion of a ureter immediately proximal to its opening in the urinary bladder. In general, ectopic ureteroceles are much larger than simple ureteroceles, have a different location within the bladder, cause more severe symptoms, and have a less favorable prognosis. Since most of them produce a recognizable pattern on excretory urography, it is important that both the radiologist and the urologist be familiar with their pathologic anatomy.

To Ericsson (1954) belongs the credit for first drawing attention to the pathologic anatomy and frequency of ectopic ureteroceles (1), although he was able to list 19 previously reported cases. His study is evidently not widely known in the United States, notwithstanding its incorporation in a monograph published in this country in 1957 (3). The purposes of the present preliminary report are to describe the pathologic anatomy of simple and ectopic ureteroceles and to record their relative frequency in the case material of the Cincinnati Children's Hospital from Jan. 1, 1950 to Oct. 1, 1959. Radiographic, cystoscopic, and surgical findings, symptomatology, and therapy will be considered in the final report.

The *pathologic anatomy* of a simple ureterocele is shown diagrammatically in Figure 1. Although the involved ureter may not terminate in the usual location on the trigone, it always opens in the urinary bladder and therefore is not considered to be ectopic. The ureterocele is contained completely in the bladder, except in those rare instances when it prolapses into the urethra (4). Occurring with equal frequency in the two sexes, such ureteroceles comprise only about one-fourth of the ureteroceles which are discovered in pediatric patients. Simple ureteroceles are usually small and do not occupy any great part of the bladder. Their radiographic appearance has been likened to a "cobra head" or "spring onion."

The characteristic feature of an ectopic ureterocele (Fig. 2) is the submucosal passage of the distal portion of the involved ureter for a variable distance within the vesical wall before terminating in the urethra. Ectopic ureters which end elsewhere than in the urethra never possess a sufficiently intimate relationship with the vesical mucosa to form ureteroceles (3). Almost always the involved ureter is supernumerary and drains the upper pole of the kidney *via* either a small pelvis or, less commonly, a point in the renal parenchyma without any identifiable pelvis (1). In either case, there is function of the involved portion of the kidney and the ectopic ureter contains urine.

Approximately 50 per cent of ectopic ureteroceles end blindly, having no communication with the urethral lumen. From a functional standpoint, however, it is of little importance whether or not the termination is patent, because the ureter passes through the internal vesical sphincter. Therefore, even when an orifice is present, as in Figure 2, emptying is seriously impeded by the contracted internal vesical sphincter or by the stream of urine in the urethra during micturition. Consequently, the ectopic ureter dilates, and the portion of the ureter which is separated from the lumen of the bladder by only vesical mucosa bulges anteriorly and superiorly to produce the ureterocele (Fig. 2). A ureterocele so formed does not have an orifice in the bladder, unless one develops secondary to infection or trauma. If differs from a simple ureterocele in another important detail; it is not completely contained within the urinary bladder. Some portion of an ectopic ureterocele invariably extends posterior to the vesical neck and the proximal urethra (1).

Ectopic ureteroceles are almost always large, the size depending in part on the length of the segment of the ectopic ureter which is located immediately beneath the mucosa of the bladder (4). The cyst frequently causes obstruction of the other ureter and sometimes of the vesical neck. Occasionally large ectopic ureteroceles prolapse through the urethra to present as "vulval cysts."

Although large, many ectopic ureteroceles are not particularly tense and, when the intravesical pressure is increased, the contents of the ureterocele are displaced into the dilated supravesical portion of the ureter with a consequent diminution or disappearance of the ureterocele. In our series, this feature frequently led to delays and errors in diagnosis.

The pressure within the blocked system is sufficiently elevated to impair function of the upper pole of the kidney. Consequently the superior pelvis and its ureter are generally not opacified during excretory urography. In addition, dilatation of this upper pelvis frequently causes recognizable lateral and inferior displacement of the lower pelvis.

In contrast to the simple type, ectopic ureteroceles rarely occur in adults. They are found most frequently in children less than three years of age and are far more common in girls than in boys. They are usually best demonstrated on excretory urography, where they are recognized in the opacified bladder as inferior and posterior oval radiolucencies which are easily confused with gas in the rectum.

Fig. 1. Diagrammatic representation of a simple ureterocele. The wall of the cyst is comprised of vesical and ureteric mucosa separated by a thin layer of ureteric muscle. Modified from Williams (4).

Frequently the associated duplex kidney can also be identified.

Present Series: Fifteen patients with ureteroceles were admitted to the Cincinnati Children's Hospital between Jan. 1, 1950, and Oct. 1, 1959. One of the patients cannot be included in this report because most of his studies were done in another city. Of the remainder, 4 patients had simple ureteroceles; 6, definitely ectopic ureteroceles; and 4, ureteroceles which were almost certainly ectopic but about which we do not have sufficient information to make an unequivocal diagnosis. The incidence in our series is comparable to that reported by Ericsson in 1954 (1). Of 20 ureteroceles in children in his series, 14 were ectopic and 6 simple.

The 4 patients in our series who had simple ureteroceles were girls. In all there was an onset of mild symptoms of cystitis between three and six years of age. In 2 instances the ureteroceles were bilateral, and in the other 2 they were located on the right ureter. All measured less than 1 cm. in diameter and were associated with barely perceptible ureteral dilatation.

The 10 patients with ectopic ureteroceles all experienced the onset of typical symptoms of urinary tract infection within the first three years of life. In no instance were the symptoms or physical findings indicative of the specific congenital anomaly. Nine of the patients were girls, and in none of these did the ureterocele prolapse through the urethra to present as a "vulval cyst." The symptoms were mild in 1, moderate in 5, and severe in 4 of the cases. Three of the patients died as a direct consequence of their ectopic ureteroceles.

The ectopic ureteroceles were large and were equally divided as to side, with no bilateral cases. In each instance, the ureterocele developed on the ureter from the superior pelvis of a duplex kidney. The superior pelvis was not visualized in any of the 9 cases in which excretory urography was employed. In 6 cases, its presence was indicated by the shape or displacement of the opacified inferior pelvis.

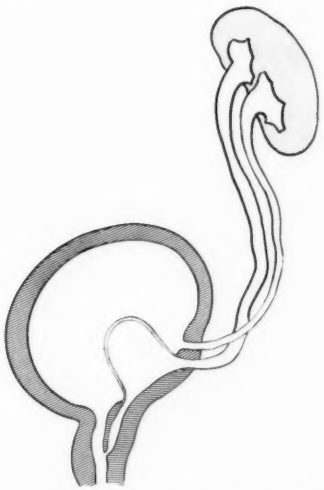

Fig. 2. Diagrammatic representation of an ectopic ureterocele. The cyst extends behind the vesical neck and has no orifice into the bladder. The cyst wall, which is represented by a double line, includes vesical mucosa and the anterior wall of the ureter. Modified from Williams (4).

Tissue from the upper poles has been examined in 5 cases, and in 4 renal dysplasia (2) was present.

The ectopic ureter was hypoplastic in one instance and moderately to severely dilated in the other 7 cases in which the size was determined. The degree of dilatation of the ipsilateral, uninvolved ureter was moderate to severe in 6 cases, and mild in 2; in 2 others, no dilatation was observed. Three patients had demonstrable duplication of the contralateral kidney, 1 with severe dilatation of the upper pelvis and ureter and minimal dilatation of the lower system. The other 2 patients had little or no dilatation of the contralateral systems. The 7 remaining patients demonstrated severe dilatation of the single contralateral systems in 1 case, moderate dilatation in 3, and minimal to no dilatation in 2.

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WORK IN PROGRESS: RADIOTHERAPY

The final sessions of the Forty-fifth Annual Meeting of the Radiological Society of North America were given over to brief accounts of new projects in diagnosis and therapy still in the preliminary stages.

Following the plan adopted several years ago for the reporting of current work in the field of radiologic physics, these papers are being presented under the heading Work In Progress.

Relative Biological Effectiveness of 0.4–1.8 Mev Neutrons for Acute Effects in the Mouse[1]

J. L. BATEMAN, M.D., V. P. BOND, M.D., Ph.D., and ELMER E. STICKLEY, Ph.D.

Studies to date of the relative biological effectiveness (RBE), of fast neutrons have been generally hindered by "smearing" at the energies investigated. Results so far, however, suggest a low RBE at higher neutron energies, with a rise below 10 Mev and a possible peak below 2 Mev. Little information has been obtained in the 0.5 to 2.0-Mev region.

The present study provides data in this area by use of essentially monoenergetic neutrons available from the p-t reaction described by G. A. Jarvis (1). Fowler and Brolley (2) indicated the energy and flux of emitted neutrons as a function of the angle of emission. Snyder and Neufeld (3) calculated the energy absorption in average tissue as a function of neutron energy for first collision recoil protons.

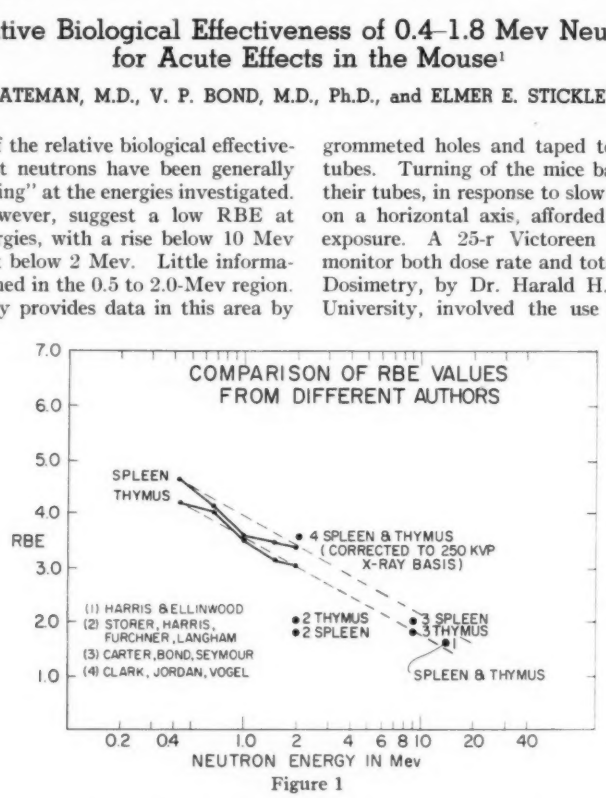

Figure 1

EXPERIMENTAL PROCEDURE

On the basis of these data, a lightweight exposure cage was built for mice, consisting of a perforated polyethylene cylinder with spaced internal styrofoam disks, to provide five energy rings. A Van de Graaff generator was employed to accelerate 2.8-Mev protons, with a tritium target. Five open-end Lusteroid centrifuge tubes placed tangentially in each ring contained the mice, the latter restrained only by their tails, which were drawn through small grommeted holes and taped to the outside of the tubes. Turning of the mice back and forth within their tubes, in response to slow rotation of the cage on a horizontal axis, afforded essentially bilateral exposure. A 25-r Victoreen chamber served to monitor both dose rate and total dose per exposure. Dosimetry, by Dr. Harald H. Rossi of Columbia University, involved the use of tissue-equivalent plastic ionization chambers in each ring, to obtain the mean absorbed dose per unit reading of the monitor.

Gamma contamination was less than 5 per cent as checked by film, the maximum being in the 1.8-Mev ring. Smearing of the five neutron energies due to target thickness and finite angle subtended by the mouse tubes revealed no overlap between rings.

A total of 760 mice, Carworth Farms CF-1 four-week-old females, were treated in six replicate exposures, each including four neutron exposures of (approximately) 25, 50, 85, and 115 rads. Suitable 250-kv x-ray groups were provided, and equal handling of all irradiated groups, plus stress control animals, was achieved.

The mice were allocated randomly to the groups. They were ether-killed four days post-treatment.

and freshly dissected organs were weighed immediately. Spleen and thymus weights in the irradiated series were averaged for each group of five animals; this figure was divided by the respective average for the stress group and expressed as per cent weight retained.

RESULTS AND CONCLUSIONS

The figures obtained were plotted against mean absorbed dose on log-probit paper, with eye fit of the best straight line representative of each neutron energy. Dose required to achieve 50 per cent organ weight loss was determined in each case, that for x-rays being divided by that for each neutron energy to obtain RBE.

Plots of RBE for spleen and thymus show in each instance a pronounced slope, higher at the low-energy end. Statistical analysis of these curves is pending, but interim evaluation at completion of four replicates revealed significance of the slope at the 95 per cent level for spleen and at the 99 per cent level for thymus. The RBE's for spleen ranged from 3.3 at 1.8 Mev to 4.6 at 0.43 Mev. For thymus, these values were 3.0 to 4.2.

Results indicate a progressive increase of neutron RBE for both spleen and thymus, with decreasing energy in the 0.43 to 1.80-Mev range. Where the range of neutron energies overlaps data from the literature, comparable biological effectiveness values are seen.

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Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

Preoperative Irradiation of Carcinoma of the Cervix

Combined Radiation-Surgical Treatment[1]

LEONARD LIEGNER, M.D., WILLIAM BERRY, M.D., and CARL OAKMAN, M.D.

At St. Luke's Hospital (New York) our interest in preoperative irradiation followed by radical hysterectomy and node dissection for cervical carcinoma has been stimulated by the realization that optimal results have probably been attained by either modality alone, as exemplified by reports from the Radiumhemmet on the one hand and the the proponents of radical surgery on the other. We feel that on both sides an unhealthy competitive philosophy prevails, which may have blinded each to the advantages inherent in the other's method.

The value of postoperative irradiation in carcinoma of the cervix has been challenged in a paper from Memorial Center (New York) by Liegner, Olson, and Nickson (1) in which it was shown that, of 86 patients with carcinoma of the cervix irradiated postoperatively, only 9 survived five years. Further analysis of this group revealed only 2 five-year survivals among 57 patients who had clinically demonstrable or biopsy-proved disease at the beginning of irradiation.

The rationale of our pilot study is based on the following factors:

1. L. H. Gray's basic work on the oxygen dependency of radiosensitivity (2) and the recent encouraging clinical exploration of the oxygen effect by Churchill-Davidson (3). Similarly we believe that preoperative rather than postoperative irradiation means irradiation in an optimally oxygenated tumor bed.

2. The possible beneficial effect of castration in carcinoma of the cervix, reported by Kottmeier (4).

3. The possible auto-immunizing effects of tumor irradiation through the absorption of tumor breakdown products.

4. The observation of Shapiro and Fugmann (5) as to better results with surgery following tumor shrinkage by radiation or chemotherapy.

5. The paradoxical findings of Cherry *et al.* (6) that some patients with cancer of the cervix with metastatic nodes did more poorly with surgical excision alone, while similar cases with positive nodes responded better to irradiation alone.

6. The observation of Coutard (7), Baclesse (8), and others that frequently what presents as extensive laryngeal or oral cancer regresses to a smaller nidus of primary disease under the influence of irradiation.

7. The limits of radical hysterectomy and node dissection and the need for exenteration when cancer of the cervix extends toward the bladder or rectum, even though these organs are not actually invaded.

8. Finally, the experimental reports of good wound healing in the presence of preoperative irradiation by Lawrence and Nickson (9 and 10).

Our paper is directed not to a study of end-results but toward an evaluation of the clinical and surgical problems inherent in preoperative irradiation followed by early surgery.

The basic requirements for the study of preoperative irradiation were as follows:

1. Irradiation was to be directed to the primary as well as the regional nodes.

2. The tumor dose was to be one that would not result in a high incidence of prolonged debilitating diarrhea, yet one that for the pelvic volume might still prove to be cancerocidal for tumors of great to moderate sensitivity and, hopefully, might at least be cancerostatic for more resistant tumors.

3. A dose-time relationship was chosen that would allow the safe administration of the minimum selected dose of 4,000 r and yet not unduly delay surgery.

4. Early surgery after irradiation was chosen to avoid possible fibrotic radiation reactions described by others. Furthermore, we wished to investigate the infrequently observed early reactions to irradiation to be found in the pelvis and to learn more about the effects on operative technic, postoperative course, the tumor, and patient survival.

The 8 cases included in this pilot study were all Stages I and II (World Health Organization). Furthermore, the combined radiation-surgical treatment was not offered patients with medical contraindications to major surgery. All patients underwent radical hysterectomy and node dissection.

The majority of patients were white; 6 were less than 36 years of age. Epidermoid carcinoma was found in all cases. A single *in situ* carcinoma is included, since this pathological diagnosis was not made on the original reading but only in review of the slide after treatment had already been instituted; we believe, therefore, that the original clinical staging of I*a* should remain.

All patients were treated with cobalt-60 supervoltage irradiation. The field planning included the whole pelvis, extending laterally to encompass the common iliacs, superiorly to cover the nodal area at the bifurcation of the aorta, and sufficiently low, inferiorly, to include all palpable vaginal disease.

Parallel opposing fields were used throughout, with cervical and paracervical shielding when radium was used concurrently. In all cases, except the 3 treated with radium and the single *in situ* case, the whole pelvic dose was 4,000 r (tumor dose) given in an overall time of approximately thirty days. The radium cases received total midline and nodal doses of around 6,000 r except in 1 case where the combined nodal dose at the lateral pelvis was 2,100 r, since cobalt irradiation had been terminated after 600 r, for nonmedical reasons.

Radiation reactions were minimal: 5 of the 8

patients had diarrhea, usually starting at 2,000 r (tumor dose). In 4 the diarrhea was severe, but was well controlled or completely subsided before surgery, except in 1 case with operation ten days post-irradiation. In this instance proctosigmoidoscopy in the operating room immediately prior to surgery showed normal bowel mucosa throughout.

The interval between the last radiation treatment and surgery varied between four days and four weeks, except in 1 patient who, because of language difficulties, could not be recalled to the hospital until twenty weeks later. The overall time between the beginning of irradiation and surgery for the same cases varied between two and eight weeks, except for the single twenty-four-week interval.

In 5 cases residual disease was found in the cervix in the surgical specimen. The time distribution of these cases suggests no greater probability of tumor being completely destroyed later rather than earlier.

At post-irradiation surgery the gross findings were very favorable, with excellent lines of cleavage in 6 of 8 patients and normal cleavage planes in 2, based on the surgeon's estimate. No radiation fibrosis, adhesions, perforation of viscera, or necrosis was observed. Peritoneal injection and edema were generally absent or, if present, of only slight to moderate degree. Hemostasis presented no problem, bleeding being no greater than normal. Any suspected fibrotic reaction paracervically or near the rectal wall, although believed at first to be radiation fibrosis, proved on examination of the surgical specimens to be malignant.

The postoperative course was exceptionally free of abdominal wound or vaginal vault complications or delayed healing. No lymphoceles resulted. No lower leg edema was noted. Pelvic hemorrhage did not occur. To date no fistulae have developed. The complications ascribed to surgery and/or irradiation were ureteral obstruction in 2 cases and diarrhea in 1, all transient and completely resolving. The morbidity was that usually seen after radical surgery, half the patients showing rapid fall of temperature within three or four days, while the other half had a daily rise to 101° or thereabouts for seven to ten days. Half the patients were discharged within two weeks, the other half between three and four weeks.

Radiation effects in the microscopic sections were marked in 2 cases and slight to moderate in 3 others. In the same patient marked changes in the cervix may be seen with minimal changes in the pelvic node metastases. In only one case were the nodes positive, and these were bilateral. In this instance the paracervical and pelvic wall contained tumor. In another case the rectal wall biopsy, negative on frozen section, was positive on fixed section. Hence, of the 8 cases the surgical staging conformed to the clinical estimation of Stage I disease. In both clinical Stage II cases the surgical staging proved to be IV.

In summary, preoperative irradiation followed by early operation was well tolerated by the patient, resulted in no increase in technical problems during surgery, and did not adversely affect the postoperative course or increase morbidity.

At this report the 8 patients are alive for periods ranging from two months to a year and a half; 7 of the 8 are free of disease, including 1 with proved rectal invasion. In 1 patient massive vaginal vault induration developed within a month of discharge from the hospital, although subsequent biopsy of the vault did not reveal tumor. She is weakened, but not going downhill, with normal bowel and kidney functions. It is now nine months since treatment and, should this induration prove to be inflammatory and resolve, with ultimate survival of the patient, the value of preoperative irradiation may well have been demonstrated, encouraging us to continue our study in this direction.

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Combination of Vasodilators and Radiation in Experimental Tumor Therapy[1]

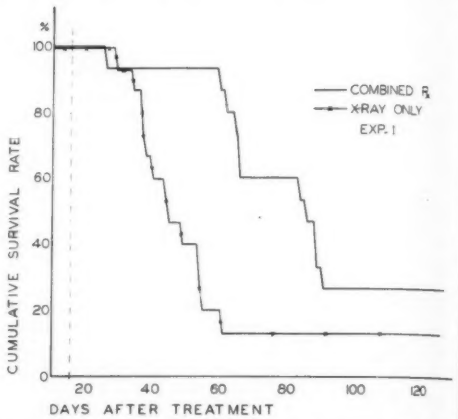
MORTON M. KLIGERMAN, M.D., FRED M. PALACE, M.A.,[2] DORA KYRYK, B.A., and HAROLD L. ATKINS, M.D.

Interest in the relationship of oxygen tension to the radiosensitivity of tissues in recent years has been generated largely by L. H. Gray and his associates (1, 2, 3). Stimulus to test the effect of breathing oxygen during the irradiation of human cancers followed the realization that oxygen might sensitize the tumor more than the adjacent normal tissues. Further support followed from the review of Thomlinson (4) of microscopic sections of a large number of lung carcinomas. He predicted that those tumors which grew in cords surrounded by stroma carrying blood vessels would most likely benefit by an increase in oxygen tension. He had observed that all tumor cords over 320 micra in diameter had necrotic centers. Assuming that these microscopic necroses resulted from relative anoxia, he suggested that an increase of oxygen tension in the capillaries in the stroma would convert some or all of the central cells with decreased oxygen tension, and therefore relatively radioresistant, into more radiosensitive cells as a result of greater diffusion of oxygen to them. Accordingly, Churchill-Davidson, Sanger, and Thomlinson (5) began the treatment of patients in a diver's pressure tank, converted for the purpose, maintaining the patient under anesthesia at 3 atmospheres of oxygen. The x-ray beam was directed to the tumor through a plastic window cut in the steel chamber.

It is the opinion of many that attempts should be made to take advantage of the oxygen effect in patients by methods which exclude the requirement of a cumbersome tank. When consulted about this problem, Lambertsen (6) suggested the use of carbon dioxide as a vasodilator to increase the blood flow to the tumor. A sympathetic blocking agent such as acetylcholine would have to be given to prevent reflex contraction of the arterioles. As part of the program to reduce the protection afforded by decreased oxygen tension in experimental tumors, such pharmacological means are under exploration in our laboratories using a transplantable hepatoma in the C3H mouse.

METHOD

Hepatoma 134 arose spontaneously in C3H mice and has consistently shown 95 to 100 per cent of takes in animals of the same strain. The tumor was minced and inoculated into the subcutaneous tissue just above the knee of the left leg. After a suitable period of growth, tumors less than 2 mm. and those greater than 8 mm. in diameter were eliminated. The animals were divided into two groups by the toss of a coin. One group was given a single x-ray dose of 2,600 r,[3] with a jig previously described (7), in which the tumor is localized under a cone measuring 1.25 cm. in diameter. The second group received the same dose of radiation and in addition were given a vasodilating drug and breathed a mixture of 94 per cent oxygen and 6 per cent carbon dioxide. This was accomplished by connecting the shielded lead chamber to the gas source with a flow rate of 8 l./min. Irradiation was started after sufficient time was allowed to flush the chamber of atmospheric air.



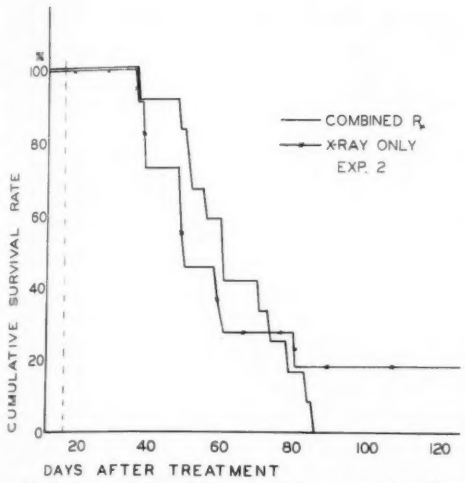
Graph 1. Animals treated with combination of tolazoline 10 mg./kg., 94 per cent oxygen and 6 per cent carbon dioxide, and 2,600 r *vs.* animals receiving 2,600 r alone. Fifteen animals in each group. Greatest difference between the two cumulative survival-rate curves is 73.4 per cent. $p < 0.001$.

Two drugs have been tested. The first was intraperitoneal acetylcholine, 0.6 mg., as a sympathetic blocking agent which permits the vasodilating action of carbon dioxide. This was administered one minute before irradiation. Two experiments were performed with this agent. The first included 28 animals with combined therapy and 29 with irradiation alone; the second, 28 in the combined group and 32 in the x-ray-only group.

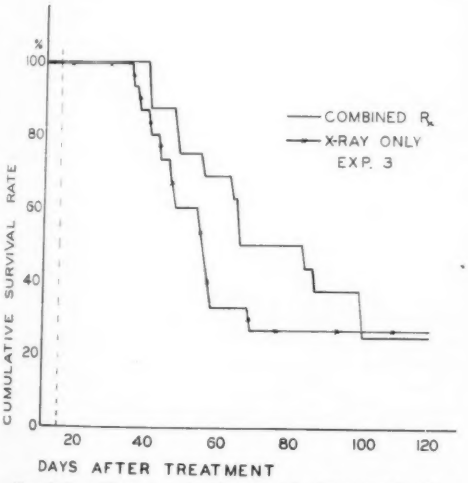
The second drug tested was tolazoline (Priscoline). Since this is a vasodilator, 6 per cent carbon dioxide was used to stimulate respiration and to increase the dissociation of oxyhemoglobin. Four groups totaling 108 animals were run concurrently but not simultaneously.[4] The tumor transplants in each group came from a different stock hepatoma 134 in these smaller experiments. The radiation dose was as described above. The combined treatment group received tolazoline at a dose of 10 mg./kg. intraperitoneally. Three minutes later, during which time the gas mixture was applied, irradiation was begun.

RESULTS

Acetylcholine: Although statistical analysis of the two curves in each experiment failed to show a

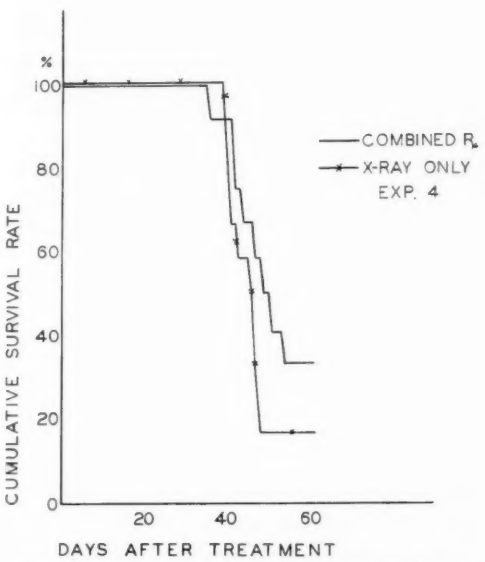


Graph 2. Twelve animals treated with combination of tolazoline 10 mg./kg., 94 per cent oxygen and 6 per cent carbon dioxide, and 2,600 r *vs.* 11 animals receiving 2,600 r alone. The greatest difference between the two cumulative survival-rate curves is 37.9 per cent. $p = 0.20$.



Graph 3: Sixteen animals treated with combination of tolazoline 10 mg./kg., 94 per cent oxygen and 6 per cent carbon dioxide, and 2,600 r *vs.* 15 animals treated with 2,600 r alone. The greatest difference between the two cumulative survival-rate curves is 35.5 per cent. $p = 0.15$.

significant difference, they proved encouraging. The cumulative survival rate curve of those animals treated with acetylcholine, 94 per cent oxygen, and 6 per cent carbon dioxide fell to the right—increased survival—of that for the group treated by x-rays alone in both experiments. Since it was recognized that acetylcholine is an evanescent drug, investigation of some of the many excellent vasodilators



Graph 4: Animals treated with combination of tolazoline 10 mg./kg., 94 per cent oxygen and 6 per cent carbon dioxide, and 2,600 r *vs.* animals treated with 2,600 r alone. Twelve animals in each group. The greatest difference between the two cumulative survival rate curves is 41.7 per cent. $p = 0.13$. Combining the Chi squares of experiments 2, 3, and 4, in which 78 animals were used, yields $p = 0.08$. When Chi squares of all four experiments are combined (108 animals) $p < 0.001$.

now in clinical use for treatment of hypertensive patients was begun.

Tolazoline: The results of the tolazoline experiments are shown in Graphs 1–4. The fraction of animals without evidence of tumor at 120 days was not affected by the treatment. The cumulative survival curves were calculated, and the difference between the two curves in each experiment was analyzed statistically.[5] It will be noted that in every experiment the cumulative survival curve in the combined treatment group falls to the right of that for the animals treated by x-rays alone. The individual Chi squares based on the greatest difference of the two curves obtained were: experiment 1, $p < 0.001$; experiment 2, $p = 0.20$; experiment 3, $p = 0.15$; experiment 4, $p = 0.13$. Combining the Chi squares of the latter three groups, with six degrees of freedom, resulted in $p = 0.08$. When the Chi squares of all four groups are combined, $p < 0.001$.

CONCLUSIONS

Although the tolazoline experiment was set up to find 20 per cent as a significant difference between the two survival curves, we hesitate at this point so to interpret our results because three of the subgroups, even when combined, altogether comprising 78 animals, are not significant at the 5

per cent or better level. We are encouraged, however, by the results to proceed along these pharmacological lines, since the cumulative survival curve in each individual experiment falls to the right of that for the x-ray control group.

789 Howard Avenue
New Haven 4, Connecticut

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[2] Aided by a summer stipend from the James Hudson Brown Memorial Fund of Yale University.

[3] Factors were 250 kv constant potential, 15 ma, target-skin distance 21.7 cm., 2 mm. Al added filtration. The dose delivered was the air dose 2 mm. below the cone surface, corresponding approximately to the center of the majority of the tumors irradiated.

[4] The experiment was set up to find a 20 per cent difference in the survival of the two groups, taking into account a type 1 error of 5 per cent and a type 2 error of 10 per cent. A minimum of 88 animals were needed.

[5] The statistical method involved the greatest difference between the two curves, using the L. A. Goodman modification of the Kolmogorov-Smirnov two-sample, one-tailed test.

Combined Radical Radiotherapy and Surgery in the Treatment of Bronchogenic Carcinoma[1]

RAUL MERCADO, JR., M.D., FERNANDO G. BLOEDORN, M.D., CARLO A. CUCCIA, M.D., and R. ADAMS COWLEY, M.D.

The purpose of this work is to evaluate the feasibility of combining preoperative radical irradiation and radical surgical extirpation in the management of bronchogenic carcinoma. This investigation is being carried out as a joint project of the Divisions of Radiotherapy and Thoracic Surgery at the University of Maryland Hospital. All patients admitted to the hospital with a diagnosis of lung cancer and with disease limited to one lung and the mediastinum are included, as well as cases which at previous thoracotomy were considered inoperable due to local extension of the tumor. Cases in which surgery was contraindicated by associated medical conditions have been excluded.

TECHNIC OF TREATMENT

In all cases a positive histologic diagnosis is obtained before initiation of therapy. If necessary, an exploratory thoracotomy is performed to obtain biopsies of the primary tumor and mediastinal nodes. Irradiation, in the form of cobalt-60 teletherapy, is then started.

The minimum volume irradiated includes the primary tumor and the entire mediastinum. In anaplastic or oat-cell carcinomas both supraclavicular areas are also treated. In every case an effort is made to include all the areas to be treated in a single volume and to avoid irradiation of the opposite lung. The treatment is divided into two phases:

1. Initially, two parallel opposing fields are employed to cover the primary tumor and the mediastinum, and treatment is carried to a tumor dose of 4,500 r in four and a half weeks. The fields extend from the sternal notch to a level 8 cm. below the carina and are of adequate width to cover the primary tumor in the lung with at least 2 cm. margin. The minimum width of these fields is 10 cm.

2 Whenever possible, treatment is completed by means of rotation therapy to include the obvious residual tumor and adjacent mediastinum, with fields 10 to 12 cm. long and 7 to 9 cm. wide. An additional tumor dose of 1,500 r is delivered in about one week. In cases where rotation is not feasible because of the relative position of the primary tumor and the lymph nodes, small parallel opposing fields are used to complete the treatment.

The supraclavicular fossae are treated with an anterior split field, extending from the mediastinal field to the middle of the neck. A given dose of 5,000 r is delivered in four weeks.

Surgery is performed two months after completion of irradiation therapy. As in other regions of the body, we consider a waiting period of six to eight weeks advisable in order to allow for the full effect of irradiation to take place and for the subsidence of the acute tissue reaction. In addition, metastases present before the initiation of therapy usually will become clinically evident during this period and useless surgical procedures will be avoided.

RESULTS

A total of 26 patients were included in this study (Table I). One-half of the patients were initially considered inoperable on the basis of previous thoracotomy or on clinical grounds. Eight patients did not have post-irradiation surgery: 4 refused operation and in 4 distant metastases developed. Of these 8 patients, 5 died within six months with metastases, 3 of them having also evidence of active tumor in the chest. Three remain alive, 1 with evidence of an active primary tumor. There was thus failure to control the primary lesion in 50 per cent. One of the patients not operated upon lived twelve months; the others three to seven months.

TABLE I: RESULTS OF COMBINED THERAPY

Deaths
1 at five months of intercurrent disease
1 postoperative
1 at eighteen months from uncontrolled disease and metastases
Patients alive with metastases
1 eighteen months (primary in kidney)
1 twelve months
Patients alive and well
Survivals: 40-21-20-16-15-14 months
2 cases recent; rest more than six months

TABLE II: HISTOLOGIC FINDINGS

Primary lesion: Biopsy positive prior to combined treatment	18	
Mediastinal nodes: Biopsy positive prior to combined treatment	3	
Findings at operation		
Primary +, Node +	1	
Primary +, Node −	6	
Primary −, Node +	1	
Primary −, Node−	10	(61 per cent)
Primary +	39	per cent
Nodes +	11	per cent
Nodes −	89	per cent (2/3 with previous biopsy)

The remaining 18 cases were subjected to thoracotomy and either a lobectomy or pneumonectomy was performed (Table I). The surgical procedures were carried out without significant added difficulty

due to the irradiation. Grossly, there was no evidence of fibrosis except when thoracotomy had been done previously. The operative morbidity and mortality were not appreciably different from what is to be expected after pneumonectomy. In 1 patient a bronchopleural fistula developed and another suffered a myocardial infarction one month after pneumonectomy; both are alive and well. There was 1 postoperative death due to a contralateral pneumothorax. Fifteen patients have remained alive for a minimum of six months, 2 of them with evidence of metastases.

Analysis of the surgical specimens revealed residual tumor in 40 per cent of the cases, manifested mainly by microscopic foci of malignant cells (Table II). On the other hand, *only 2 of the specimens showed residual tumor cells in the mediastinal or hilar lymph nodes.* In 3 cases in which metastatic lymph nodes had been found on exploratory thoracotomy prior to irradiation, 2 proved to be sterilized following radiotherapy. The overall incidence of lymph node metastases in this group appears to be considerably lower than the usual stated average of 60 per cent.

The following conclusions may be drawn from this study:

1. Irradiation, in high dosage, of a large segment of one lung and the entire mediastinum can be carried out without significant complications.

2. Surgery following this type of irradiation is feasible without undue morbidity.

3. Cases inoperable due to local or mediastinal extension can be rendered operable by preoperative supervoltage irradiation.

4. Although residual tumor is found in about 40 per cent of the cases, it appears to be possible to sterilize hilar and mediastinal node metastases in a high percentage of patients.

5. Surgery is always necessary after radical supervoltage irradiation, due to the significant number of residual primary tumors after treatment.

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[1] From the Division of Radiotherapy, Department of Radiology (R.M., F.G.B., C.A.C.), and the Division of Thoracic Surgery, Department of Surgery (R.A.C.), University of Maryland Hospital, Baltimore, Md.

Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

Scintillation Scanning of the Normal Human Spleen Utilizing Sensitized Radioactive Erythrocytes[1]

PHILIP M. JOHNSON, M.D., JOHN C. HERION, M.D., and STEWART L. MOORING, M.D.

The human spleen has not been selectively demonstrable by scintillation scanning, although its partial delineation has occasionally occurred in liver scans following administration of colloidal gold 198. Recently, however, Hughes Jones *et al.* plotted "isocount lines" over the spleen in two patients exhibiting splenic trapping of radioactive red cells (1). The purpose of this report is to describe our preliminary experience with scintillation scanning of the normal spleen following its differential concentration of gamma-emitting red cells.

The method employed in this investigation is a modification of a technic described by Jandl *et al.* (2) for study of the physiology of erythrocyte destruction. It has been shown by these and other workers (1, 3) that certain modifications of ABO-compatible transfused red cells lead to rapid sequestration and destruction of these cells, chiefly within the liver and spleen. Splenic trapping is quantitatively greatest when $Rh_0(D)$-positive red cells, sensitized by coating with incomplete anti-$Rh_0(D)$ antibody, are administered to normal $Rh_0(D)$-positive persons (2). The survival of such abnormal cells, after transfusion, has been studied by serial measurement of circulating red cell radioactivity, and the sites of sequestration found by external body surface counting, made possible by prior labeling of the red cells with chromium 51.

Observations were made on 9 adults with intact, nonpalpable spleens, with $Rh_0(D)$-positive blood and without clinical or laboratory evidence of hematologic or splenic disorder. Six milliliters of sterile sensitized Type 0, $Rh_0(D)$-positive red blood cells were tagged with 150–200 microcuries of sodium chromate (Cr^{51}) and injected into an antecubital vein from which a control sample of blood was first withdrawn.[2] Serial samples of 5 ml. of whole blood were drawn from the opposite arm. Serial scintillation counting over the liver, spleen, and thigh was performed with two lead-shielded scintillation probes fitted with a 1-inch crystal and wide-angle collimator. The pulses from each probe were amplified and transmitted into a linear rate meter from which counts per minute were directly read. Scanning of the spleen was performed with a lead-shielded 2-inch crystal with a straight-bore cylindrical collimator with aperture of 5/8 in. diameter attached. Pulses from the crystal were amplified and transmitted into a spectrometer with its channel of 100 Kev width "focussed" on the gamma photopeak of chromium 51.

Clearance of Sensitized Radioactive Erythrocytes from the Blood: In 6 cases the number of circulating sensitized radioactive red cells decreased exponentially (Fig. 1), with a half-survival time ranging from 24 to 98 minutes (mean 46.7 minutes). In Case 3,

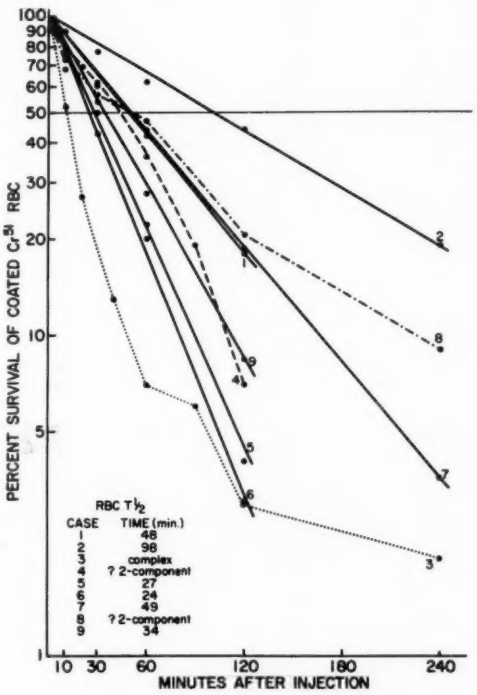

Fig. 1. Semilogarithmic plot of levels of circulating red cell radioactivity as a function of time for all 9 cases. In 6 cases the curves are exponential; in 3 the curves cannot be described on the basis of a single exponent.

in which marked hepatic red cell sequestration occurred, the half-survival time was 11 minutes; in the other 2 it was approximately 42 minutes (Case 4) and 50 minutes (Case 8). The half-survival time in Cases 1, 2, and 4–9 tended to approximate the time required for 50 per cent of peak splenic radioactivity to appear.

Accumulation of Radioactivity in the Spleen and Liver: Logarithmic plot of the means of the net count rates, corrected for decay and normalized to a dose of 200 microcuries, demonstrated an exponential rise in radioactivity in the spleen and liver (Fig. 2). The rate of rise and the maximum level were considerably higher in the spleen in 8 of the 9 cases. In both organs the phase of accumulation was virtually completed about four hours after injection, the mean spleen:liver ratio being 5.3:1 (range 2.9–7.0) at that time. The level of maximum radioactivity was maintained for about forty-four hours, beginning four hours after injection. During this "plateau" period the mean spleen:liver ratio increased slightly

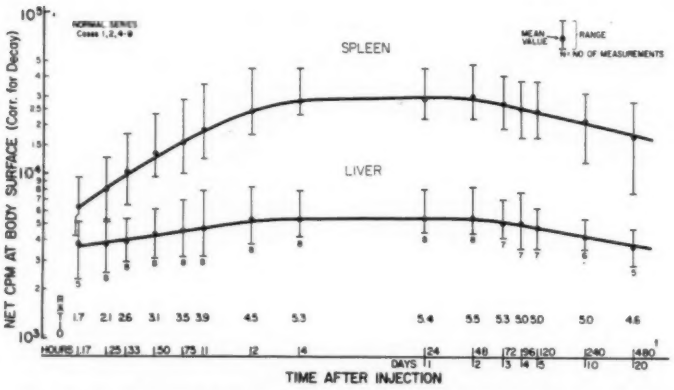

Fig. 2. Logarithmic plot of mean values of radioactivity at the effective centers of the spleen and liver as functions of time (8 cases). These data have been corrected for background (by subtracting the count rate at the thigh), for decay, and for differences in the administered dose of chromium 51. Note that each curve consists of three linear components of varying slope.

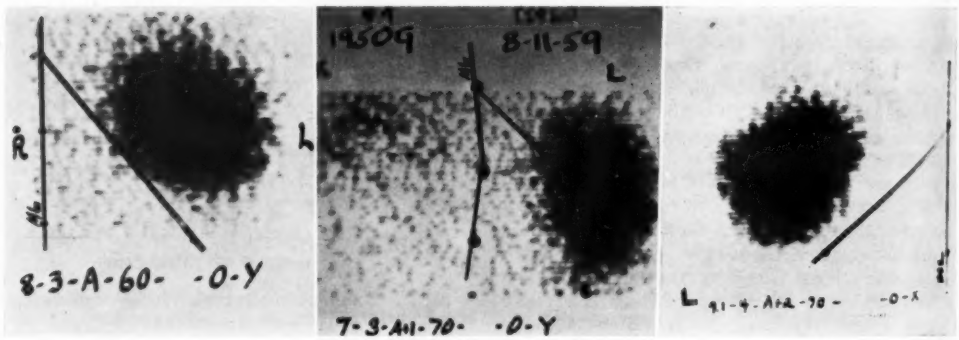

Fig. 3 (left). Photoscan of spleen in Case 2 made eight days after administration of 6.0 ml. of sensitized red cells labeled with 200 μc of chromium 51. The scan is viewed as though the patient were supine. The body midline (ML) and the lowest palpable left posterior rib (oblique line joining ML) are indicated. Symbols refer to factors employed in the scan.

Fig. 4 (center). Photoscan of spleen in Case 4 made one day after injection; 200 μc of chromium 51 were used. Note evidence of slight radioactivity in the region of the right hepatic lobe.

Fig. 5 (right). Photoscan of spleen in Case 9 made twenty-four hours after injection. 150 μc of chromium 51 were used. This scan is viewed in the position in which it was made (patient prone).

to a maximum of 5.5:1 forty-eight hours after injection; this small increment may have been due to statistical fluctuations in counting rates as well as to a further rise in splenic radioactivity. After the forty-eighth hour there was a gradual exponential release of chromium from both organs.

Scintillation scans of the spleen were made in 7 of the 9 patients (Figs. 3, 4, and 5).

In each of the 7 scans a localized concentration of radioactivity was demonstrated in the left upper abdominal quadrant. This was quite homogeneous and moderately well defined at its periphery, despite cyclic positional variations of the spleen caused by respiration. The size of the splenic image varied considerably: the diaphragmatic (supero-lateral) aspect tended to be slightly flattened; the splenic "notch" was never demonstrated. Hepatic radioactivity did not interfere with splenic delineation, and was noticeable only in the center of the right hepatic lobe (Fig. 4). There was no immediate or delayed clinical or hematological reaction to the procedure.

The ultimate place of scintillation scanning of the spleen will become clear through additional investigation. Further technical refinements and study of the normal spleen are evident needs. Scanning of the diseased spleen, and of the splenic bed in lienectomized patients should prove of great interest. The method may have value in objectively recording changes in spleen size in response to various physiological or therapeutic stimuli, and in the differential diagnosis of left upper quadrant masses. It is perhaps possible that sensitized red cells binding millicurie amounts of chromium 51 may serve as a

means for selective therapeutic irradiation of the spleen, and it is not unlikely that the method, modified by employing only a few microcuries of chromium 51, will enable rapid external localization of an impalpable spleen to facilitate splenic puncture.

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[1] From the Departments of Radiology and Medicine, The School of Medicine, University of North Carolina, Chapel Hill, N. C. This investigation was supported by Grant No. A-1996 (C1) of the National Institute of Arthritis and Metabolic Diseases, National Institutes of Health, Bethesda, Md. Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

[2] A detailed description of the methodology will be published.

A New Method of Implantation of the Base of the Tongue[1]

THOMAS H. S. WOLEVER, M.D., and QUENTIN T. BROOKS, M.D.

Believing with others (1) that low intensity interstitial radium, where possible, is superior to external beam therapy for malignant lesions requiring a high dose, and having experienced the difficulties of placing and maintaining radium in the base of the tongue, we have developed and are testing a new technic of implantation in this area. We have used it to date only for small lesions, but feel that it could readily be adapted to large ones.

The technic takes advantage of the Teflon tube method of implantation described by Morphis (3), which allows easy and accurate placement of radium sources with very little exposure to the operator, since the plastic tubes which make up the implant are placed before there is any exposure at all. Palpation for location can be done with impunity, and accuracy assured, since one is touching only inactive tubes.

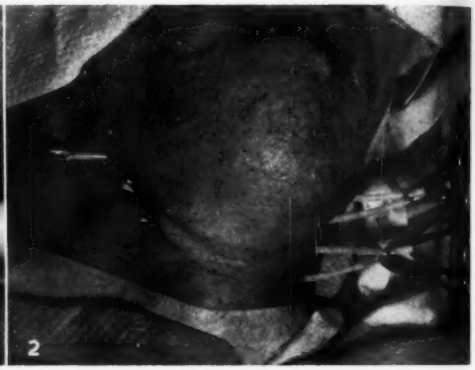

Fig. 1. Photograph showing Steinmann pin passing through tongue from skin to skin.
Fig. 2. Photograph showing tubes in place and secured at one end, ready for insertion of radium.

With the patient under general anesthesia, a Steinmann pin, prepared as described by Morphis, is attached to the end of the tubing. Then, with the left index finger in the vallecula, on the lesion, the right hand can be used to palpate externally and to place the tube by pushing the Steinmann pin through the tongue from skin to skin, as shown in Figure 1. To facilitate introduction of each succeeding tube, the wire used to push in the radium may be placed in the previously inserted tube for palpation. Thus, with the palpating finger as a guide, both the direction and separation of the tubes, as well as the depth from the tongue surface, are controlled. As each tube is placed, a Michel skin clip is fastened to one end and the other end is held in a hemostat until the entire implant is satisfactory (Fig. 2). If desired, dummy needles or even simple pieces of wire may be placed in the tubes and x-ray films made to check the distribution before radium is removed from its lead carrier. It is then a simple matter to place radium in each of the tubes and quickly secure the other end with another Michel clip. It may be necessary to use spacers to maintain the sources in the center of the tongue. For this purpose we found solder wire of the proper diameter easily cut at the operating table with suture scissors. Because of the difficulty of placing crossing needles, radium needles of the dumbbell type are desirable. In addition, there is no necessity then to puncture the oral mucosa.

At the Veterans Administration Hospital, Houston, Texas, there have been 6 cases of carcinoma of the base of the tongue in the past five years. One was treated surgically and 3 had external beam therapy only. The remaining 2 were treated by the technic described here, one following external beam therapy, where tumor persisted, and the other by this method only. Insufficient time has elapsed for comparison, but our 2 patients have remained tumor-free for nine and six months, respectively, while those 6 treated by other methods, only 1 lived more than a year.

Case I: A 63-year-old man had a lesion of the base of the tongue without node metastases treated by external (2 Mev) beam therapy. Two months after completion of treatment, a persistent ulcer on the tongue side of the vallecula showed squamous-cell carcinoma on biopsy. Radium was implanted by the method described. The patient continued to swallow normally. On removal of the radium, arterial bleeding was encountered and external carotid ligation was necessary. Nine months after treatment the tongue is normal to inspection and palpation. No difficulty from the ligation has been experienced.

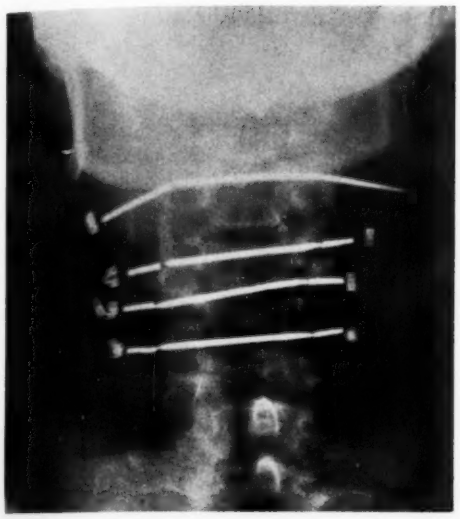

Fig. 3. Roentgenogram showing distribution of radium with metallic spacers in place.

CASE II. A man of 62 was seen with a 1.0-cm. lesion on the tongue side of the vallecula which on biopsy proved to be squamous-cell carcinoma. He had no lymphadenopathy. Radium implantation by the method described was carried out as the only treatment. This man required a nasogastric feeding tube while the implant was in place. Six months after treatment the tongue is normal to both inspection and palpation.

The two major complications anticipated with this type of implant were encountered in our 2 cases. Case I, however, demonstrates that deglutition can continue in spite of relative fixation of the tongue and Case II demonstrates that arterial puncture is not always encountered. We intend to continue this treatment for suitable lesions.

We hope that the simplicity of this technic will induce more radiotherapists to use interstitial radium, the most satisfactory agent for attaining a large dose to a small volume of tissue, thus possibly improving the results of treatment of carcinoma at this site.

1200 M. D. Anderson Blvd.
Houston, Texas

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Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

Creatinuria as a Possible Index to Radiation Fatigue[1]

S. KUROHARA, M.D., P. RUBIN, M.D., and L. HEMPELMANN, M.D.

Muscular fatigue is a common complaint in patients undergoing radiation therapy. In total-body irradiated animals in which extreme degrees of muscular weakness are observed, creatinuria appears to resemble in mechanism that found in muscle-wasting disorders, *e.g.*, muscular dystrophy.

The 24-hour urinary creatine and creatinine and the fatigue symptomatology of 14 patients undergoing radiation therapy were determined before and at weekly intervals during and after treatment. The degree of creatinuria might be related to the anatomical site of irradiation and to the amount of radiation absorbed, particularly to the amount of muscle mass irradiated. The severest fatigue symptoms were observed in patients with the greatest degree of creatinuria. The various mechanisms or factors influencing creatinuria were considered.

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[1] From the Divisions of Experimental Radiology and Radiation Therapy, University of Rochester School of Medicine and Dentistry, Rochester, N. Y. Work supported by National Institute of Health Funds.

Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

Time-Dose Relationship of Radiation; Fibrosis of Lung[1]

JOHN C. EVANS, M.D.

Since supervoltage equipment has become available in the United States, an increasingly large number of patients with bronchogenic carcinoma have been referred for radiation therapy. Those accepted for treatment usually have fairly well localized but inoperable tumors and are treated primarily for palliation of cough, hemoptysis, or other symptoms. In an effort to obtain prolonged survival, tumor doses have been recommended in excess of 6,000 r delivered over four to six weeks. This frequently results in crippling radiation fibrosis of the lung, producing more symptoms than were due to the original disease.

An effort was made to determine the dose which could be safely administered to a significant volume of lung without producing symptomatic fibrosis. An initial series of 160 cases were studied on the basis of symptoms and x-ray findings. Of this group, only those surviving over three months after completion of therapy were evaluated, since a shorter follow-up interval did not allow adequate time for fibrosis to become evident. Only 62 cases fulfilled the survival requirement, and approximately half were thought to show radiographic evidence of radiation fibrosis. Only 2 patients received a mid-lung dose in excess of 6,000 r, corrected for lung transmission, and protracted over eighty days. None had symptoms thought to be attributable to radiation damage.

An additional 12 cases could not be accurately evaluated for the presence of fibrosis, because of rapidly recurrent disease, atelectasis, and unresolved pneumonia in the irradiated segments. Autopsy evaluation of some of the cases thought to show radiation fibrosis radiographically confirmed our inability to differentiate these conditions. A second problem was to estimate accurately the dose received at various places in the lung, because of unequal transmission through aerated and nonaerated lung, mediastinal contents, and bony thorax.

Factors have been given (Jacobson) for correction of lung dose, but these imply a field placed over the peripheral lung of uniform density.

At present we are attempting to evaluate the time-dose relationship of radiation tolerance of lung, determining the mid-chest dose by means of transit dose measurements. A simplified chamber for measuring the transmission dose has been developed (by Mr. R. J. Schulz), using a 1-cm. collimator and a Victoreen "r" meter. The transmission dose through increasing thicknesses of Presdwood gives a linear semilogarithmic plot, indicating that radiation scattered from the patient does not enter the measuring instrument. The transmission through a small field over the peripheral tumor is compared to a similar field over a Presdwood phantom. A correction factor for depth dose calculation in each patient can then be derived.

The presence or absence of radiation fibrosis in those patients surviving over three months following irradiation is determined by histologic sections of the lung at autopsy. Characteristic changes in the alveolar wall, lumen, and bronchi (Bergmann) are graded histologically. The few cases studied to date suggest that a maximum tumor dose not exceeding 5,500 r in sixty days of treatment (equal increments, five days per week), with a field area not over 150 sq. cm., will cause only minimal radiation fibrosis in the lung.

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Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

New Developments in High Energy Electron Beam Therapy with the 35 Mev Brown Boveri Betatron[1]

M. SEMPERT

Electron beams have now been used several years for therapy. The clinical results up to this time are favorable and, therefore, interest in this new mode of radiotherapy increases more and more, not only for superficial but also for deep therapy.

In the Radiation Laboratory of the Swiss Brown Boveri works we have been interested for a long time in the physical and technical problems of electron therapy. The intention of this paper is to give a short survey of the 35-Mev betatron and the latest development of electron-focusing apparatus for therapeutic application.

Deep therapy with electrons demands an electron energy of up to 30 to 40 Mev. Figure 1 represents the depth dose curves in water for electron beams with energies between 5 and 35 Mev. An energy of 35 Mev, for example, is necessary for a relative depth dose of 80 per cent at 11 cm.

The Brown Boveri betatron produces x-rays and electron beams of continuously adjustable energy from 5 to 35 Mev and is also equipped with a 125-kv diagnostic x-ray unit for beam localization purposes. Fixed-field, pendulum, rotational, and tangential therapy may be carried out.

Figure 2 is a schematic diagram for electron beam therapy. The electrons leave the accelerating tube through a window, where they are scattered and suffer an energy loss of 1 Mev. Dose rate and dose are measured by means of a thin-walled transmission type ionization chamber. To collimate high-energy electron beams effectively, a sandwich-like composition of aluminum, brass, and lead layers, giving sharp beam boundaries with only low production of stray electrons and secondary x-rays, is used.

Depth dose obtained with high-energy electrons is good, as long as the radiation field is not small. The curves in Figure 3 illustrate the dependence of

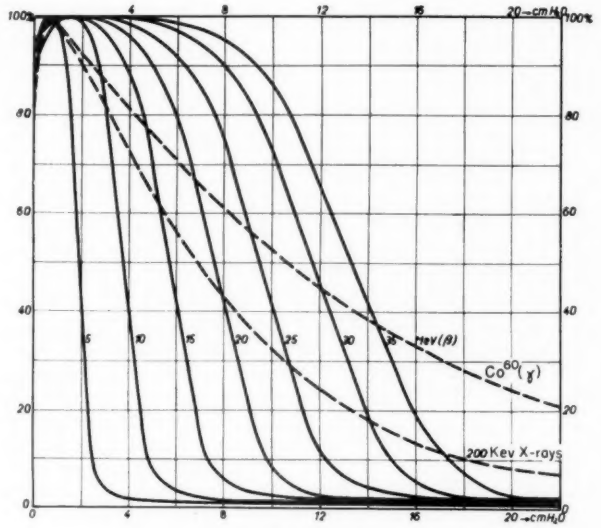

Figure 1

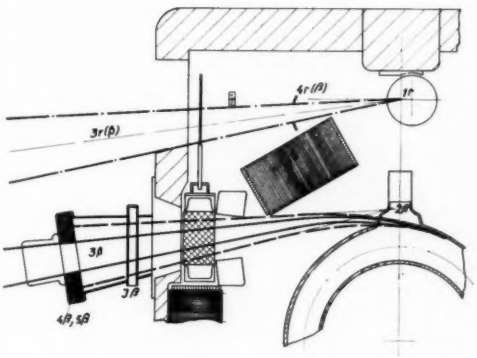

Fig. 2. Paths of electron beam and respective diagnostic beam. 1r. Focus of 125-kev x-ray tube. 3r (β). Axis of diagnostic beam. 3β. Axis of electron beam. 4r(β). Collimator for diagnostic beam. 4β, 5β. Collimator for electron beam. Jβ. Transmission type ionization chamber.

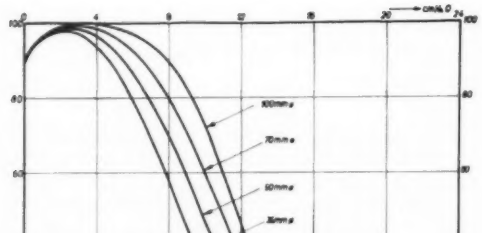

Figure 3

speed about the axis. The entire circular area within a diameter of approximately 8 to 12 cm. at the skin of the patient is sprayed with electrons coming through the air gap of the magnet. A cone of electrons is thereby produced in the body, focusing at a depth of about 10 to 20 cm. Thus, depth-dose curves with a reduced skin dose and increased depth dose are achieved. A great variety of different isodose distributions can be obtained by variation of the conditions for focusing. The essential parameters, which can be varied, are as follows: The magnetic field strength, variable by alteration of the air-gap distance or by means of magnetic shunts, the shape of the magnet poles, the distance between lens and skin, the shape of the collimator, and the electron energy.

An example of an isodose distribution using the magnetic lens system may be cited. The volume enclosed by the 80 per cent isodose surface has a

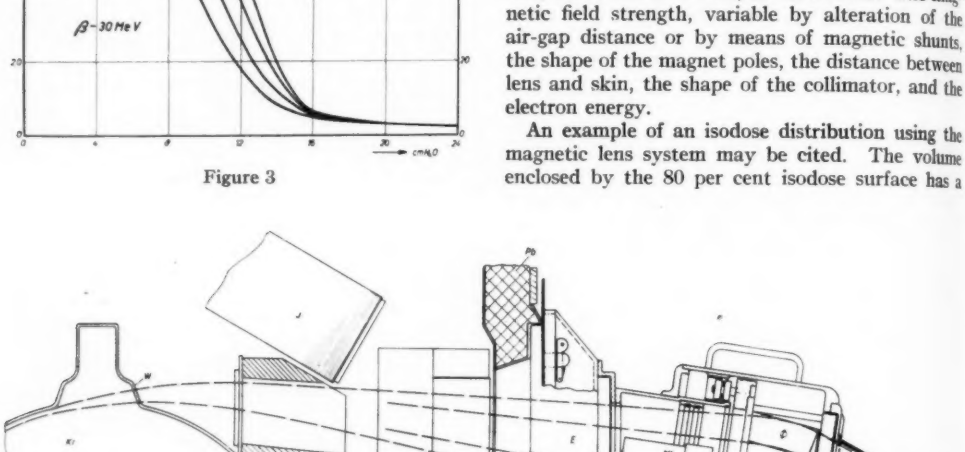

Fig. 4. Magnetic lens for electron beam focusing. Kr. Donut. W. Window. H. Precollimator. J. Yoke. B_1, B_2. Lead shutters for 31-Mev x-ray beam collimation. E. Electron beam. Mt. Motor. ϕ Permanent magnet. K. Electron beam collimator. T. Beam localizer. Mk. Ionization chamber.

depth dose on diameter of the irradiation fields for 30-Mev electrons. A relative depth dose of 72 per cent, corresponding to a diameter of 10 cm. and a depth of 10 cm., is decreased to 33 per cent if the diameter is reduced to 3.5 cm.

In order to improve the depth-dose curves and isodose distributions for small fields we have developed *magnetic focusing electron lenses.* Figure 4 shows schematically the construction of such a focusing device. Because of the technical difficulties in focusing the entire beam, only part of the beam, about 10 to 20 per cent, is used. The electrons to be focused pass through the air gap of a strong permanent magnet and are therefore deflected toward the axis.

A small motor rotates the apparatus at a constant diameter of approximately 2 cm. and a height of 3 cm., at 30 Mev. The skin dose is only 30 per cent. Another adjustment of the same lens system and an increase of the electron energy to 36 Mev gives larger field sizes. Depth-dose values of 80 per cent are obtained at a depth of 12 cm. Until the development of the lens system it was not possible to achieve, in a single exposure, dose distributions of this type.

This new method, which can also be combined with an automatic movement of the patient, will offer quite new opportunities for electron treatment.

[1] From Brown Boveri & Co., Ltd., Baden, Switzerland.

Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

In-Vivo Dosimetry with Miniature Glass Rods[1]

STANLEY J. MALSKY, M.A., M.Sc., BERNARD ROSWIT, M.D., CHARLES AMATO, B.Sc., CYPRIAN B. REID, B.Sc., SOL M. UNGER, M.D., CHARLES SPRECKELS, B.E.E.

A glass rod microdosimeter (1 × 6 mm.), utilizing the concept of radiophotoluminescence (1), is being used for human *in vivo* measurements in all modes of radiation therapy. Due to its miniature size and integrating ability, it is an ideal dosimeter for medical use (2). The undesirable feature of energy dependence in the range of 200 kev to 1.3 Mev is being corrected by a suitable gold shield designed by the authors (3). A fluorimeter electronic reader, with modifications designed by the U. S. Naval Research Laboratory, assures reproducible and stable results.

In human subjects with cancer, the miniature dosimeters were placed with ease in the pharynx, the esophagus, the bladder, and other deep organs. Technics were devised to introduce these units directly into tumors and normal body tissues. In all the clinical experiments, there was a remarkable degree of correlation between the dosimeter reading and the calculated dose when beam irradiation (260 kv, 1000 kv, cobalt 60), radium implants, or isotope therapy was employed.

The following investigations are currently in progress: (*a*) comparison of barium, potassium, aluminum metaphosphate glass and lithium, manganese, aluminum metaphosphate glass, to determine the possibility of the latter's use with a wide gamma energy spectrum; (*b*) employment of varying shield thicknesses for gamma ray spectroscopy; (*c*) the response of these dosimeters to various gamma and beta emitting isotopes; (*d*) the behavior of these glass rods in a radiation field of both gamma rays and neutrons.

A more complete description of the work and the results will be reported shortly.

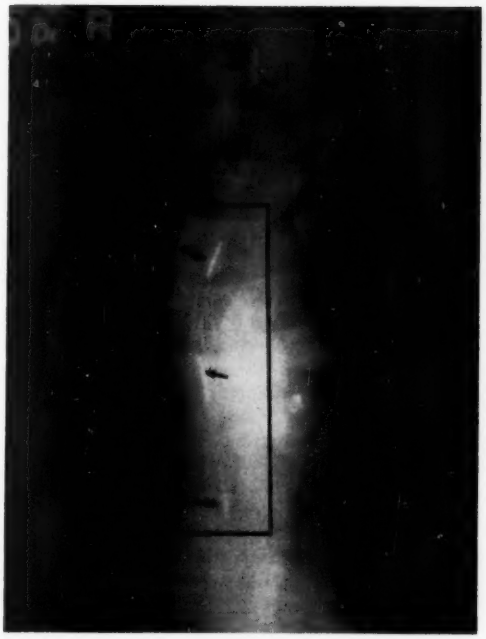

Fig. 1. Three glass dosimeters in gold jackets lie in tandem in rubber tube in esophagus of patient with esophageal carcinoma. In the 1,000-kv beam the glass dosimeters recorded a dose only 2 per cent less than the calculated dose.

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Presented at the Forty-fifth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 15–20, 1959.

WORK IN PROGRESS: RADIOLOGICAL PHYSICS*

Total Body Scanner for High Energy Gamma Rays[1]

J. S. LAUGHLIN, Ph.D., J. W. BEATTIE, M.S., K. COREY, M.S., A. ISAACSON, M.S., & P. KENNY, M.S.

In order to facilitate metabolic studies in man with certain radioactive isotopes, a special scinti-scanner has been designed, constructed, and placed in operation. This has been particularly designed to be used with isotopes with high-energy gamma rays, such as calcium 47, zinc 65, etc., and to permit scanning of any portion of the body conveniently. Some of the special features are reported here.

The region scanned is 6 × 2.5 feet in a horizontal plane. A more limited vertical plane can also be accommodated. Two scanning heads were designed: one to move above the patient on an elevated track, and the other to move below the patient on a floor-mounted track. The scanner has been placed in operation with only the upper unit completed. A thin Lucite platform supports the patient, and folds away when a bed or stretcher is preferred. The scanning heads can move with either continuous or step-wise motion. The speed can be adjusted from 0.1 to 10 cm./sec. in orthogonal directions in the horizontal plane. The vertical positions of the heads are also controlled by motors and the upper head can be rotated through a complete hemisphere.

Each head is provided with 4 × 4-inch crystal with a 4-inch diameter photomultiplier tube. The crystal and tube are surrounded by a combination lead and tungsten shield 12 inches in diameter. A focusing collimator of tungsten with 19 holes and a focal length of 3 1/2 inches beyond its face is employed. The total weight of each collimator and shield assembly is 600 lb. A linear amplifier, single channel pulse height analyzer, and decade scaler are used to accumulate the pulse counts before printing.

The data are displayed with a unique system which permanently records all the information received by the crystal. When the head is used with a step-wise motion, counts are accumulated during its stationary interval and printed while it advances to its next counting position. The distance between counting positions may be adjusted from 3/16 to 3 inches and the time interval may be adjusted from 1 to 60 seconds.

A specially built electrical output-writing typewriter prints the counts accumulated at each position at a corresponding point on a roll of paper 2 feet wide. A 3-digit print-out is employed, with the use of two-colored ribbon with shift to accommodate large numbers. Identifying marks can also be printed as desired for any particular count. The synchronization between the scanner head and print-out position is accomplished by having the typewriter carriage driven by synchromotors which are controlled by the motion of the scanner.

[1] From the Division of Biophysics, Sloan-Kettering Institute, Memorial Center, New York, N. Y.

On Measuring Exposure Dose in Phantoms with Thimble Chambers[1]

GAIL D. ADAMS, Ph.D.

One convenient method of eliciting absorbed-dose information in tissue or phantoms is to determine the local exposure dose and utilize calculated conversion factors, such as those in Figure 8 and Table II of NBS *Handbook 62*. For a variety of x-ray qualities in the conventional range, these factors may be used to convert exposure dose (roentgens) to absorbed dose (rads).

The Victoreen condenser r-meter can be calibrated in air to indicate roentgens over a substantial x-ray quality range. However, when this detector is immersed in an extensive condensed medium, its mere presence is bound to alter the quantity to be detected; in this case the photon flux. It was our object to estimate the size of the correction resulting from this alteration.

We identify two specific sources for the alteration: the metal stem and the air content in the ionization volume. The influence of the metal stem is estimated by placing a similar stem (without thimble) in opposition to the existing stem, with some attention to spacing and presuming that the alteration due to the first is the same as that due to the one added. Clearly, secondary photons are not fully generated in the shadow of the stem, so the reading obtained will be less than the exposure dose.

The air-presence correction is estimated by an unusual extrapolation technic. A series of thimbles (25, 100, 250, 1,000-r ranges) were used for this purpose, simply because they could be calibrated for a substantial quality range and because of a relatively limited angular dependence on sensitivity. With the use of an x-ray generator with a transmission monitor and preset exposure control, it is possible to transfer calibration factors between chambers. Thus, for each of the four chambers a quality correction factor is assignable as soon as an assignment of quality is made. The data of Green-

* The papers presented here were submitted for publication in October 1959 and were read at the Forty-fifth Annual Meeting of the Radiological Society of North America (Section C), Nov. 18, 1959.

ing and Wilson provided the easiest quality assignments.

Measurements of both corrections have been made for four x-ray qualities, two field sizes, and four depths in a large Presdwood phantom. For most practical situations, the reading obtained was 2 to 8 per cent low due to the stem absorption and 5 to 15 per cent low due to the presence of air in the ionization volume. Since the air correction represents a balance between lack of absorption of primary and secondary photons (produced outside the detector) and lack of production of secondaries in the air, it was not clear at the outset whether this correction would be additive or subtractive. There are circumstances (unusual) of no apparent correction.

[1] From the AEC Radiological Laboratory, University of California Medical Center, San Francisco, Calif.

Cavity Chamber Theory[1]

W. C. ROESCH, Ph.D.

Cavity chamber theory is concerned with the relation of the absorbed dose in the cavity wall to the energy absorbed per unit mass in the cavity material. The ratio of these two quantities is called the relative stopping power and is denoted by s. For the case of mono-energetic charged particles of energy T_0 emitted uniformly throughout the wall material, the theory developed by Bragg, Gray, and Laurence for s can be given by

$$\frac{1}{s} = \frac{1}{T_0}\int_0^{T_0} N(T) S_\varrho(T) dT \qquad (1)$$

Here $N(T)\,dT$ is the number of emitted particles that have dropped to an energy in dT at T and that cross a small sphere, per unit area of the sphere, at any point in the wall material in the absence of the cavity; $S_\varrho(T)$ is the stopping power for charged particles of energy T for all energy losses to ionization or excitation of the cavity material; radiation losses are neglected.

Recently two papers (1, 2) discussed improvements in the theory that allow for the fact that the energy losses of charged particles take place in discrete amounts and result in the production of energetic delta rays. These considerations require modifications of Equation 1. S_ϱ is made to include only those energy losses for which the energy remains in the cavity, *i.e.*, is not carried out by delta rays. $N(T)$ is made to include energetic delta rays, but is still taken as the flux in the absence of the cavity. The lower limit of integration is also changed to some value greater than zero. Burch (2) discussed the differences in the two theories.

A complete cavity chamber theory must account not only for the effects of the delta rays but for the difference between the $N(T)$ that actually exists in the cavity and the $N(T)$ in the absence of the cavity. We must expect that differences in $N(T)$ and effects of delta rays may occur in the same chamber and be difficult to separate either in experiment or theory.

Fortunately, it is possible to simplify the theoretical problem to some extent by separating the effects of the emitted particles from those of the delta rays. This can be done as follows. Consider a spherical cavity of radius a. We need only allow for variations in any quantity with distance, r, from the center of the cavity (since nonisotropic sources will produce the same effects in the cavity as isotropic ones, only the latter need be considered). Now the energy absorbed in the cavity will equal the difference between the energy lost in the cavity by emitted particles and the net energy carried out of the cavity by delta rays. This permits the formula for s

$$\frac{1}{s} = \frac{1}{{}^4/_3\pi a^3 T_0}\left[\int_0^a 4\pi r^2 dr \int_0^{T_0} N(T, r)\, S_\varrho(T) dT - \frac{4\pi a^2 G}{\rho_g}\right] \qquad (2)$$

Here $N(T, r)$ differs from $N(T)$ of Equation 1 in that it is the actual flux existing in the cavity and is therefore a function of position in the cavity. As in Equation 1, it includes only the emitted particles, not any delta rays. S_ϱ is the same as in Equation 1, *i.e.*, no energy losses to delta rays are omitted, but radiation losses are neglected. G is the net energy per unit area carried by delta rays across the surface of the cavity; G is taken as positive when the net flow of energy is directed outwards. Calculation of s from Equation 2 appears to be difficult. No numerical results will be reported here. It will be shown how the equation has proved very useful in qualitative analysis of cavity chambers.

In the limit of very small cavity sizes the first term of Equation 2 approaches the value of $1/s$ given by Equation 1. The approach is governed solely by how fast $N(T, r)$ approaches the value it has in the absence of the cavity. $N(T)$ is very nearly the inverse of the stopping power of the wall, so that its product with S_ϱ is greater (less) than unity if the atomic number of the walls is greater (less) than that of the cavity material. If we denote s from Equation 1 by s_1 and s from Equation 2 by s_2, we may express the first term of Equation 2 by a Taylor's series,

$$\frac{1}{s_2} = \frac{1}{s_1}(1 - cr + \ldots) - \frac{3G}{\rho_g a\, T_0} \qquad (3)$$

where c is a constant.

The behavior of the second term in this last equation depends on that of G. For chambers of large radii, G will approach a constant value characteristic of a plane surface. Then for large a the second term will behave as $1/a$. For very small chambers, G will approach zero, but the presence of a in the

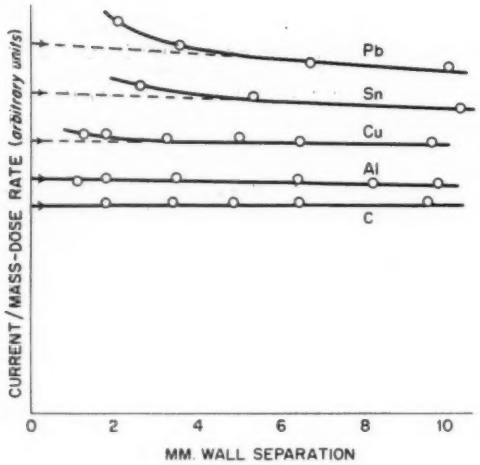

Fig. 1. Experimental data for the ion current per unit mass of gas per unit dose rate in the walls (Attix, *et al.*, 4). The arrows on the vertical axis indicate the values calculated from the Bragg-Gray relation.

denominator makes it important to know just how G approaches zero. For very small radii, those delta rays crossing the cavity lose energy in proportion to the distance they travel, *i.e.*, in proportion to a. This loss of energy produces a proportional energy flux, G. For the delta rays produced in the cavity material, the number produced will be proportional to the volume, *i.e.*, a^3, while the surface they cross is proportional to a^2; so G is again proportional to a. Since G is proportional to a for small chambers, the second term in Equation 3 approaches a constant value. In other words, the delta ray effects do not vanish as the cavity is made smaller. The previous delta ray theories were not able to establish this point.

This discussion indicates that the ion current per unit mass of gas in small ion chambers of given composition but variable size should approach linearly the value calculated from the usual Bragg-Gray theory, Equation 1, as the chamber is made smaller. Superimposed on this linear approach, however, will be a deviation due to the delta ray effects. This deviation will increase as the chamber is made smaller and will have a finite limiting value.

In Figure 1 are shown the data for the ion current per unit mass of gas per unit dose rate in the walls obtained by Attix, DeLaVergne, and Ritz (4) for completely enclosed chambers. The arrows on the ordinate axis are the values calculated from the Bragg-Gray theory. The data show the predicted behavior but do not go to sufficiently small chamber size to show the finite limiting value for the delta-ray effect.

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[1] From the Hanford Laboratories, General Electric Company, Richland, Wash. Work performed under Contract No. AT(45-1)-1350 for the U. S. Atomic Energy Commission.

Recombination Loss in Ionization Chambers in a Pulsed Beam[1]

ROBERT LOEVINGER, Ph.D.

The linear electron accelerator on which the present results were obtained has a repetition rate of 60 pulses per second and a pulse length of one microsecond, giving a peak-to-average current ratio of greater than 10^4. Boag (1) has given an approximate theory for ionization chamber recombination loss in a pulsed beam, from which the following can be derived: the fraction f of the ionization collected can be expressed (for f not less than 0.9) as $f = 1 - \alpha x$, where $\alpha = 1.5d^2/nv$; d is the gap, in centimeters for a plane chamber, and an "effective" gap for cylindrical and spherical chambers; n is the repetition rate in pulses per second; v is the chamber volume in cubic centimeters; the ratio of the mean collected current to the collecting voltage is $x = I/V\ m\mu amp/kv$.

In order to fit the experimental data, it has been found necessary to modify this equation by

TABLE I: RECOMBINATION LOSS IN IONIZATION CHAMBERS IN A PULSED BEAM (Loevinger)

Ion Chamber	Approx. Volume (c.c.)	Recombination Loss $\left[\frac{\% - \text{kv}}{(\text{"r"/sec.})^p}\right]$	p	Calibration Constant $\left(\frac{\text{"r"/sec.}}{\text{m}\mu\text{ amp.}}\right)$	Range Tested: "r"/sec.	Range Tested: kv
25 r Victoreen	1.62	0.38	0.9	1.85	0.4–40	0.02–1.5
100 r Victoreen	0.43	0.22	0.9	6.98	0.6–70	0.02–1.5
250 r Victoreen	0.175	0.23	0.9	17.0	0.3–40	0.08–1.5
Conducting plastic	0.021	0.093	0.7	143	0.2–200	0.01–0.5
Bomke	0.014	0.17	0.5	210	0.3–100	0.01–0.5

letting $x = I^p/V$. Values of p appreciably less than unity have been found for small ionization chambers. Results of the measurements are given in Table I. All chambers listed, except the conducting plastic chamber, are commercially available. As an example of the use of these results, one may consider the 100-r Victoreen chamber in a radiation field of 5 r/sec., with a collecting voltage of 300 volts. Then the recombination loss is $0.22 \times 5^{0.9}/0.3 = 3.1$ per cent.

The values given in Table I apply only to an accelerator with the repetition rate and pulse length cited above. It is planned to make further measurements, on this and other accelerators, further to test the theory, in the hope of obtaining recombination loss values of general validity.

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TABLE I

Kvp	Total Filter (mm. Al)	Barrier No.	r/ma-min. at 1 m.	ma-min. for 0.10 r at 1 m.
100	2.5	None	4.5×10^{-1}	...
		1	1.4×10^{-5}	7100
		2	3.2×10^{-3}	31
		3	4.5×10^{-3}	22
		4	5.1×10^{-2}	2.0
		5	1.9×10^{-1}	0.53
		6	5.6×10^{-3}	18
		7	2.75×10^{-4}	360
		8	1.8×10^{-5}	5600
150	3.5	None	6.7×10^{-1}	...
		1	1.05×10^{-2}	95
		2	1.6×10^{-2}	6.25
		3	2.7×10^{-2}	3.7
		4	1.5×10^{-1}	0.67
		5	4.3×10^{-1}	0.23
		6	3.2×10^{-2}	3.1
		7	5.0×10^{-3}	20
		8	2.5×10^{-3}	40

Table I presents data for 8 panels, including 3/8-in. rock lath only and a panel of plaster not containing barium. Some measurements were made at 200 and 250 kvp, but it appears that under no reasonable circumstances would any of these panels provide adequate useful-beam protection. To obtain the ma-min. for 0.10 r at d feet, multiply the figure for 1.00 m. by $(d/3.28)^2$. Table II describes the barriers.

Work in progress and future work include data on other materials, including combinations of lead and building materials and of barium plaster and building materials, data at 200 and 250 kvp, data

TABLE II

Barrier No.	Composition	Lb./sq. ft.*	Thickness (in.)*
1	4 parts barium sand, 1 part plaster (on metal lath)	15.3	1
2	1 part fine $BaSO_4$, 1 part barium sand, 2 parts sand, 1 part plaster (on 3/8-in. rock lath)	7.5	5/8
3	1 part fine $BaSO_4$, 1 part sand, 1 part cement (on 3/8-in. rock lath)	7.8	5/8
4	6 parts sand, 1 part cement (on metal lath)	10.9	1 1/4
5	3/8-in. rock lath	1.65	3/8
6	2 parts barium sand, 3 parts sand, 1 part cement (on 3/8-in. rock lath)	7.2	5/8
7	3 parts barium sand, 1 part sand, 1 part plaster (on 3/8-in. rock lath)	7.5	5/8
8	6 parts barium sand, 3 parts fine $BaSO_4$, 2 parts cement	15.3	7/8

* Not including backing.

[1] From the Department of Radiology and the Biophysics Laboratory, Stanford University, Stanford, Calif. This work was performed under contract with the Atomic Energy Commission.

Barium Plaster as a Barrier to X-Rays Generated at 100 kvp and at 150 kvp[1]

HOWARD L. HALLOCK, B.S., ARNOLD FELDMAN, M.S., and DIMITRY MORKOVIN, Ph.D., M.D.

Studies were made of the effectiveness of various formulations of barium plaster as barriers to x-rays (broad-beam attenuation of the useful beam). A General Electric Maxitron Two-Fifty x-ray therapy machine with a light localizer was used for all measurements. Radiation was measured at a distance of 1 meter from the target with a Victoreen r-meter, Landsverk ionization chambers, Keleket pocket dosimeters, and a Tracerlab ion-chamber survey meter. The other instruments were calibrated against the Victoreen r-meter. In order to make the results quite conservative, it was decided to place the measuring instruments 2 inches behind the barriers. Data (not presented here) show that this is not a highly critical factor over a range of about 8 inches.

Since plastered surfaces are likely to be standard in respect to thickness and composition, it would seem more convenient for protection planning to have available data for each of a variety of plasters indicating WUT, ma-min., that would result in an exposure dose of 0.10 r for controlled areas (0.010 r for noncontrolled areas) at a number of convenient distances. Then it can be decided on the basis of the likely value of WUT whether a given plaster panel will be suitable. The idea would be even more applicable to bricks and tiles, which are made in strictly standard sizes.

for double-thickness panels, and data on the effectiveness of the materials as secondary radiation barriers.

NOTE: We wish to express our appreciation to Mr. Emery Begley for constructing the plaster panels.

[1] From the Porter Hospital, Denver, Colo. (H. L. H.), and the University of Colorado Department of Radiology, Denver, Colo. (A. F. and D. M.).

An Improved Automatic Signal Plotter[1]

ARTHUR COLE, Ph.D.

An improved version of an instrument exhibited at the 1958 meeting of the Radiological Society of North America will be described.

Two-dimensional contours (*i.e.*, isodose, isodensity, isopotential curves) are plotted automatically as follows: A fast response detector is driven by perpendicular reversible motor drives. One motor provides a scan motion, the other a compensation motion balancing an error signal generated when the detector signal differs from a selected comparison signal. In order that the detector may scan a continuous closed path, the scan and compensation roles of the motors are alternated and reversed sequentially. This is accomplished *via* a control circuit which automatically advances a four-position sequence switch when a 1 per cent error signal of the proper polarity is sustained for several seconds. The effect is to map a contour in a clockwise path of four sequences involving four "right turns" of the drive system.

In addition, automatic control functions remove scan and stylus power when the error is greater than 0.5 per cent, maintain proper sequential scanning when the contours extend outside limit positions, assure stable operation when the contour shows a discontinuity or sharp gradient, select successive levels for plotting, and enable the detector to "search" for selected contours.

The motion of the detector is transferred to a remote read-out table by means of an X-Y servomotor system which drives the recording stylus. Read-out potentiometers driven into balance with corresponding pick-up potentiometers on the plotter table determine the stylus position.

Maximum plotting speed is 36 inches per minute. Typical plotting time for 10 complete contours over an area 10 × 25 cm. is about six minutes.

A second operation mode (area plot) is provided in which the detector is driven in a "raster" or scan and index pattern. The stylus records only when the detector is either inside or outside a chosen contour. This mode is useful for plotting distributions from multiple (radioactive) sources.

Some transducer-amplifier combinations used sucessfully are: scintillation crystal with photomultiplier tube, ion chamber and electrometer amplifier, and pen-light bulb (moving with the detector) or fixed flood lamp with selenium or phototube detectors for isodensitometry studies.

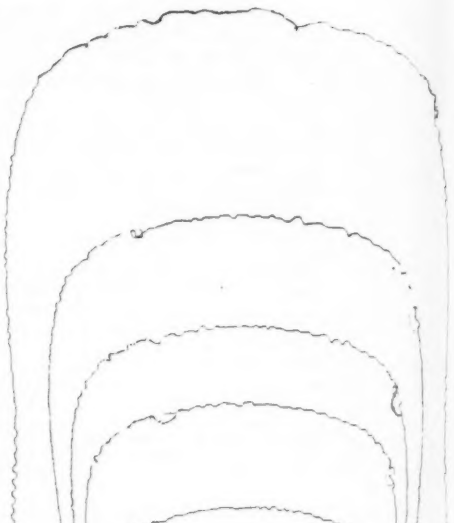

Fig. 1. Typical recording. Plot of isodose distribution from a cesium-137 therapy source; 6 × 10-cm. cone at 16 cm. S.S.D. (6-cm. scan). Curves are 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 95 per cent of maximum (100 per cent). A 1-mm. Nichrone wire loop stylus is heated to form a record on Thermo-Fax heat-sensitive paper. Plotting time about six minutes. (Cole)

[1] From the Physics Department, The University of Texas M. D. Anderson Hospital and Tumor Institute, Houston 25, Texas.

Cell Dosimetry[1]

ARNOLD FELDMAN, B.S., and DIMITRY MORKOVIN, Ph.D., M.D.

In vitro single cell cultures of human and other cells can be used for dosimetry of ionizing radiations. From the measured per cent "survival" (*i.e.*, per cent escaping reproductive death) the absorbed dose under the irradiation conditions in question can be inferred by reference to a calibration curve

obtained under "standard" conditions, provided that the biological effectiveness of the radiation in question relative to that used in calibration is known.

If a known number of single cells are inoculated into a glass Petri dish, they promptly settle, so that during x-irradiation photoelectrons from glass add to absorbed dose in the cells. The absorbed dose is then not simply R (exposure dose at cells) times f (rads in soft tissue per roentgen).

The problem of "excess" photoelectrons arises from the nature of dependence of photoelectric effect upon atomic number and photon energy.

If single irradiated cells, as distinguished from mass cultures or undamaged cells, could be grown reliably and reproducibly on materials of the same effective atomic number as soft tissue, this complication would not arise.

To avoid the extra dose from glass photoelectrons, the cells in this study were irradiated either while in suspension or while settled on tissue-equivalent materials and subsequently transferred onto glass for better growth. The results of these experiments indicate that the absorbed dose in the radiation-sensitive structures concerned with cell replication when irradiated on glass is, for h.v.l. 3 mm. Al, 1.4 as much as the exposure dose, and, for h.v.l. 1.5 mm. Cu, 1.33 as much (rather than respectively 0.895 and 0.96 as much, as would be erroneously assumed if the photoelectrons from glass are ignored, as is still done in some laboratories). The foregoing is an example of the application of the cell dosimeter in determining absorbed dose in a transition zone, where electron equilibrium does not obtain.

The results can be checked by estimating the distance from the glass of the radiation-sensitive structures concerned with cell replication. The estimated distance agrees well with what is expected on the basis of the known size of the cells.

[1] From the University of Colorado, Department of Radiology, Denver, Colo. This work was supported by grants from the U. S. Public Health Service, the U. S. Atomic Energy Commission, and the American Cancer Society.

Microangiography of Bone in the Study of Radiation Changes[1]

HARLEY C. CARLSON, M.D., MARVIN M. D. WILLIAMS, Ph.D., DONALD S. CHILDS, Jr., M.D., MALCOLM B. DOCKERTY, M.D., and JOSEPH M. JANES, M.D.

In a study of possible vascular changes in bone following irradiation and an evaluation of microangiography in their demonstration, the right hind legs of 17 albino rats ten weeks old were irradiated, with an air-exposure dose of 1,020 r generated at 130 kv and filtered by 5 mm. Al. The animals were sacrificed two to thirty days thereafter. Both hind legs of each were perfused with either a 50 per cent suspension of finely divided barium sulfate (Micropaque) or a 25 per cent suspension of thorium dioxide (Thorotrast). The femurs were decalcified and embedded in wax, and sections 100 microns thick were made for microradiography.

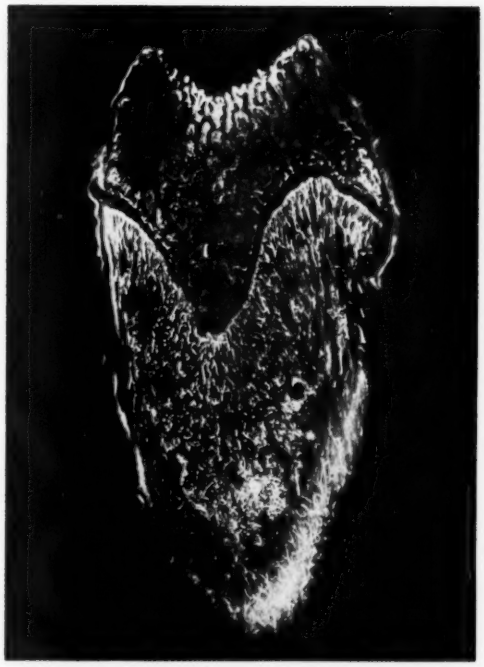

Fig. 1. Normal microangiogram of section of lower end of rat femur perfused with Thorotrast. Note rich vascular suppy of metaphysis adjacent to cartilaginous growth plate. Section was 100 microns thick. × 10. (Carlson et al)

The primary equipment for radiography was a General Electric x-ray diffraction tube with a beryllium window and Kodak 2-in.-square high-resolution plates. The tube was operated at 15 kv, 25 ma, and the film was exposed for fifteen seconds.

Micropaque provided good demonstration of the larger vessels in the cancellous bone and marrow cavity. Thorotrast, on the other hand, showed small vessels in great detail, but not the larger ones; apparently it drained out before fixation could take place. Also, with Thorotrast the completeness of filling of various portions of bone varied considerably from specimen to specimen. Used together, the two media provided a satisfying demonstration of the vascular supply of bone.

When the microangiograms of the normal and irradiated sides were compared, no significant difference was observed in the vascular supply of the femur. However, the thorium-oxide particles appeared to diffuse through the vascular wall into the extravascular space to a larger extent in the irradiated specimens. This difference was seen only

in the metaphysis just under the growth plate, and not in the vessels of the cortical bone.

The histologic sections prepared two to sixteen days after irradiation revealed striking hypocellularity of the marrow. Disruption of the orderly transformation of cartilage into bone at the growth plate was first seen on the sixteenth day. No intrinsic vascular changes could be identified, and there seemed to be no decrease in the number of vessels per unit area.

[1] From the Mayo Clinic and Mayo Foundation (H. C. C., Fellow in Radiology; M. M. D. W., Section of Biophysics; D. S. C., Section of Radiology; M. B. D., Section of Surgical Pathology; J. M. J., Section of Orthopedic Surgery), Rochester, Minn. The Mayo Foundation is a part of the Graduate School of the University of Minnesota.

Preliminary Survey of Radium 226 and Radium 228(MsThI) Contents of Drinking Water[1]

HENRY F. LUCAS, B.S., and DOUGLAS P. KRAUSE, B.S.

As part of an epidemiological survey to determine the effects on man of long-term exposure to low levels of radiation, an extensive survey is being made of the natural Ra^{226} content of municipal drinking waters in the Middle West (1–3). Concentrations as high as 36 $\mu\mu$c/liter have been found in water from wells penetrating deep sandstone formations of Ordovician or older age. In contrast, less than 1 $\mu\mu$c/liter has been found in water from surface sources or from wells penetrating other aquifers.

Populations consuming water of various Ra^{226} content are grouped in Table I. It is seen that an Ra^{226} content greater than 10$\mu\mu$c/liter has been found thus far only in Illinois water which is consumed by 30,000 people. The total population identified to date in Illinois, Wisconsin, and Missouri as consuming water with an Ra^{226} content in excess of 1 $\mu\mu$c/liter is 800,000, of whom about one-half consume water containing more than 4 $\mu\mu$c/liter of Ra^{226}.

TABLE I: SUMMARY OF POPULATIONS CONSUMING WATER AT VARIOUS Ra^{226} LEVELS

State	Concentration ($\mu\mu$c/liter)	Number of Cities	Population*
Illinois	0 – 0.99†	134	1,068,610
	1.0 – 3.9	46	228,054
	4.0 – 9.9	38	316,291
	10 – 36	19	30,261
Missouri	0 – 0.99†	11	67,177
	1.0 – 4.0	3	43,267
Wisconsin	0 – 0.99†	19	131,966
	1.0 – 3.9	11	131,224
	4.0 – 6.6	4	51,199

* 1950 census.

† Includes data on water sources of all types, in addition to deep sandstone.

Measurements have been made of the Ra^{228} (MsThI) contained in a number of these Illinois drinking waters. For this preliminary study (4–5), samples were selected to provide a wide geographical distribution for all well types. These data indicate that a high Ra^{228} content is found only in high Ra^{226} water from wells penetrating the deep sandstone formation. Concentrations of Ra^{228} as high as 8 $\mu\mu$c/liter were found. As expected from previous Ra^{224} (ThX) measurements (6), nearly equal concentrations of Ra^{226} and Ra^{228} were found in waters from deep sandstone formations near Chicago. In waters from other areas, however, the ratio of Ra^{228}/Ra^{226} was not constant (varying from 0.04 to 2.4), indicating that the concentrations and ratios of Ra^{226} and Ra^{228} are uniform only over very limited geographical areas. The Ra^{228} and Ra^{226} concentrations and corresponding ratios are summarized in Table II for three roughly delineated geographical zones; Zone I has low Ra^{228} and high Ra^{226} concentrations; Zone II has high and nearly equal Ra^{228} and Ra^{226} concentrations; whereas Zone III has relatively low Ra^{228} and Ra^{226} concentrations. These measurements are being extended not only to the remaining regions where water is known to be obtained from deep sandstone formations, but also to available skeletal specimens of their inhabitants.

TABLE II: VARIATION OF $Ra^{228} - Ra^{226}$ CONCENTRATION WITH GEOGRAPHICAL LOCATION

Geographical Location	Number of Samples	Range ($\mu\mu$c/liter) Ra^{228}	Range ($\mu\mu$c/liter) Ra^{226}	Average Ratio Ra^{228}/Ra^{226}
Zone I	5	1.3 – 3.4	15 – 36	0.12
Zone II	9	3.8 – 7.9	2.3 – 11	0.71
Zone III	10	0.9 – 2.0	3.0 – 8	0.46

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4. KRAUSE, D. P.: Radiological Physics Division, Argonne National Laboratory, Semiannual Report, ANL-5967: 126–128, 1959.
5. KRAUSE, D. P.: Radiological Physics Division, Argonne National Laboratory, Semiannual Report, ANL-6049. In preparation.
6. STEHNEY, A. F.: Acta radiol. **43**: 43–51, January 1955.

[1] From the Radiological Physics Division, Argonne National Laboratory, Lemont, Ill. Work performed under the auspices of the U. S. Atomic Energy Commission.

EDITORIAL

Reports Received at the Ninth International Congress of Radiology

At the Ninth International Congress of Radiology, held in Munich, July 23 to 30, 1959, Reports of the Commissions on Radiologic Units, Radiological Protection, and Stage Grouping were presented as follows:

Report of the International Commission on Radiological Units and Measurements (ICRU)

The ICRU has been unusually active since its meeting in 1953. This activity has been due to a number of reasons: One was the introduction of a new quantity and unit for radiation measurement; another has been due to the necessary collaboration with the ICRP in radiation protection problems of global interest; and a third relates to the necessity of collaboration with numerous other international bodies having certain interests in common with those of the ICRU.

The following meetings have been held:

1. Geneva, April 1956, for ten days.
2. Mexico City, July 1956, for one day.
3. New York, November 1956, for ten days, in conjunction with the ICRP, to organize a joint study for the U. N. Scientific Committee on the Effects of Atomic Radiations.
4. Geneva, April 1957, for ten days with the ICRP.
5. Geneva, September 1958, for twelve days.
6. Munich, July 1959, for three days.
7. In addition, committees and task groups of committees have met on several occasions.

An extensive report on radiation units, measurements, and dosimetry which began in 1955 was completed and published early in 1957[1]. This included many new data and other material necessary when radiation measurements are made and/or expressed in energy units (rads). Much of this has involved the development of new data by individual workers. Since publication of the 1957 report, the entire material has been under further study and extension. Most of this was reviewed at the meetings in Geneva in 1958 and Munich in 1959, and preparation of the 1959 report is essentially completed.

The joint study with the ICRP was published in 1957,[2] after submission to the U. N. Scientific Committee.

As a result of conferences in 1955, the ICRU established a consultative status with the World Health Organization. This has proved to be a very fruitful relationship in that WHO has aided the ICRU materially in its meetings. We have also established a consultative relationship with the International Bureau of Weights and Measures (BIPM). At a meeting with the BIPM in April 1959, it was established that the BIPM would, for the time being, look to the ICRU for primary guidance in matters of radiation units and standards.

Establishment of a consultative status with the International Atomic Energy Agency is now under consideration. Arrangements have been made with several other international bodies to exchange observers at meetings.

During the past few years, it has become increasingly evident that the scope of interest and concern of the ICRU has expanded considerably beyond that of radiology alone. It has been necessary to accept these challenges as they arose. The situation points up rather clearly that the future course of action of the ICRU must include close working relationships with international bodies in addition to the ICR. These matters have been discussed extensively with the ICRP but no conclusions have been reached.

Costs of operating the ICRU have increased enormously, both in terms of money and manpower. A detailed estimate of these costs is being prepared. The approximate income of the ICRU since 1956 is as follows:

1. International Society of Radiology	$ 525[3]
2. U. N. Scientific Committee (with ICRP)	10,000
3. Rockefeller Foundation	7,500
4. World Health Organization	7,000
5. UNESCO	5,000

Item 1 has been used mainly for small incidental operating costs, translations, stationery, etc. Items 2, 3, and part of 4 have been primarily to pay travel expenses. About half of item 4 has been provided in an indirect way through the supplying of interpreters, secretarial services, special conference room facilities, printing, etc. Item 5 was for the construction of special ionization chambers for intercom-

paring national x-ray standards. The above costs represent only about one-third of the total cost of the ICRU over the past three years, not counting the salary costs. All salary costs, and about two-thirds of the travel costs, have been borne by the parent organizations of the individuals involved; this cannot continue at this pace indefinitely.

The intensive activity will probably continue indefinitely and points up the critical need for a paid secretary for the ICRU. The present burden is more than can reasonably be expected of present members in addition to their normal work. As the major portion of the work of the ICRU is of direct concern to radiologists, it is hoped that radiological organizations throughout the world can bear a greater portion of the costs of operation.

The legal status of the ICRU has been questioned, particularly, in connection with the donation of funds from other organizations. Accordingly, the possibility of incorporating the ICRU is being studied, and a joint committee with the ICRP has been established to formulate the necessary rules and statutes.

Changes in ICRU membership are as follows:

Resigned: Prof. H. Holthusen, member since 1925 (elected member emeritus). Prof. R. Sievert, member since 1928 (elected Senior Adviser). Prof. G. Failla, member since 1950 (elected Senior Adviser).

The Commission acknowledges, with heartfelt gratitude, the extremely important contributions of these men to its work, and expresses the hope that they may continue to assist the ICRU, if only on an informal basis.

New members, 1959–62: K. K. Aglintzev, U. S. S. R.; H. Franz, Germany; H. H. Rossi, U. S. A.; M. Tubiana, France.

Commission officers from 1959–62: L. S. Taylor, *Chairman;* L. H. Gray, *Vice-Chairman;* H. O. Wyckoff, *Secretary.*

The following committee chairmen were elected: *Committee I:* W. B. Mann to replace W. E. Perry (deceased); *Committee II:* A. Allisy to replace H. O. Wyckoff; *Committee III:* J. W. Boag to replace L. H. Gray; *Committee IV:* B. Combée, continued; *Special Committee on Radiation Quantities and Units:* H. O. Wyckoff.

Two new committees were established: *Committee V:* Joint Committee with the ICRP on "Radiation Protection Dosimetry"; *Temporary Committee:* Jointly with the ICRP, on "Rules and Statutes."

By unanimous resolution, the ICRU:

1. Expressed its appreciation for the untiring efforts of its secretary, Dr. H. O. Wyckoff. The success of our work over the past three years is due largely to him.

2. Expressed its thanks and appreciation for the magnificent contributions to the success of our meetings in Munich, made possible by Herr Hanns Braun of Bayer House.

3. Thanked the ICR, its president, Dr. Rajewsky, and the local Committee for their great efforts in our behalf during the Munich meetings.

LAURISTON S. TAYLOR
Chairman

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[1] National Bureau of Standards Handbook 62: Report of the International Commission on Radiological Units and Measurements (ICRU), 1957.

[2] Exposure of Man to Ionizing Radiation Arising from Medical Procedures; an Enquiry into Methods of Evaluation. Physics in Med. & Biol. **2**: 107–151, October 1957.

[3] For the period 1959 to 1962 the sum of $3,000 has been allocated to the ICRU.

Report on Decisions at the 1959 Meeting of the International Commission on Radiological Protection (ICRP)

The period since the Commission's last regular meeting in 1956 has been the most active in its history. Because of rapid developments in the field of nuclear energy and the more widespread use of radiation sources of all types, the scope of the work has increased beyond the field of medical radiology into all fields of radiation protection, including industrial uses as well as the exposure of the general public.

In 1955 the United Nations established a Scientific Committee on the Effects of Atomic Radiation to collect and evaluate information on radiation exposure and radiation effects. In addition, bodies such as the World Health Organization, the International Labour Office, the Food and Agriculture Organization, and the International Atomic Energy Agency are actively interested in radiation protection problems and look to the International Commission on Radiological Protection for guidance. Although the primary responsibility of the Commission has been to the radiological profession, it has had to widen its scope and has accordingly been active not only during the last two international Congresses of Radiology but also in the intervening period.

Amendments to the 1953 (1) Recommendations were reported to the Mexico Congress and published in 1957 (2). Revised Recommendations of the Main Commission were adopted in 1958 and printed early in 1959 (3). Reports of the various Committees exist at present in various stages of preparation. The Report of Committee II on internal radioactive substances is already in press (4). A revised version of the Committee III Report, which is essentially a code of practice for the radiological profession, was approved during the 1959 meeting and will be published in the near future (5). The Report of Committee IV on high energy and heavy particle radiation is undergoing a final revision. Committee

V has prepared a report on the disposal of radioactive waste from hospitals and laboratories and is proceeding as rapidly as possible to prepare a further report on the disposal of waste from atomic energy establishments.

The Commission has an official relationship with the World Health Organization and the International Atomic Energy Agency. There has been close cooperation with the United Nations Scientific Committee on the Effects of Atomic Radiation, and the Commission, jointly with the International Commission on Radiological Units and Measurements, has on two occasions accepted its invitation to perform special studies. The results of the first study on the evaluation of gonad dose from medical procedures were published in 1957 (6). The second study, on the evaluation of exposure relevant to somatic damage, has been initiated, and a report is to be prepared before the end of 1960.

The Commission also co-operates with the International Labour Office and the Food and Agriculture Organization and has invited them to send observers to future meetings. The Commission has been invited to send observers to appropriate meetings of the International Organization for Standardization and the United Nations Educational, Scientific, and Cultural Organization.

During the 1959 meeting, the Commission discussed its basic Recommendations (3) and, although no substantial changes were made, a number of explanatory statements were drafted. These statements, which will be presented in the following text, include such subjects as the irradiation of pregnant women, the maximum doses to individuals in the population at large, the interpretation to be placed on the paragraph dealing with the contamination of public air and water supplies, and the hours of work and vacation of radiation workers.

A grant from the Rockefeller Foundation made it possible for the Commission to invite a number of nonmember experts on dose-effect relations to participate in the Munich discussions and be available for consultation.

During the preparation of this statement the ICRP has had the following composition.

1956–59 (Including the Munich Sessions)

R. M. Sievert, Chairman (Sweden)
G. Failla, Vice-Chairman (U. S. A.)
W. Binks, Secretary[1] (Great Britain)
L. Bugnard (France)
H. Holthusen (Germany)
J. C. Jacobsen (Denmark)
R. G. Jaeger (Germany)
W. V. Mayneord (Great Britain)
K. Z. Morgan (U. S. A.)
R. S. Stone (U. S. A.)
L. S. Taylor (U. S. A.)
E. A. Watkinson (Canada)
Sir Ernest Rock Carling, Chairman Emeritus (Great Britain)

1959— (Present Composition)

R. M. Sievert, Chairman (Sweden)
E. E. Pochin, Vice-Chairman (Great Britain)
W. Binks (Great Britain)
L. Bugnard (France)
H. Holthusen (Germany)
J. C. Jacobsen (Denmark)
R. G. Jaeger (Germany)
J. F. Loutit (Great Britain)
K. Z. Morgan (U. S. A.)
H. J. Muller (U. S. A.)
R. S. Stone (U. S. A.)
L. S. Taylor (U. S. A.)
E. A. Watkinson (Canada)
Sir Ernest Rock Carling, Chairman Emeritus (Great Britain)
G. Failla, Vice-Chairman Emeritus (U. S. A.)
B. Lindell, Secretary (Sweden)

EXPLANATORY STATEMENTS AND AMENDMENTS TO THE 1958 RECOMMENDATIONS

In the 1958 (3) Recommendations all maximum permissible doses are expressed in rems without reference to the appropriate RBE values. Such reference will be given in the reports of the Committees concerning the application of the recommendations in various specified fields. The RBE values used in each of the Committee reports to be published are consistent with those published in 1954 (1).

The following statements refer to particular paragraphs in the 1958 Recommendations:

Explanatory statement of Paragraph 46 (see also Paragraphs 35 and 41): It has been recommended that "medical exposure" be excluded from the calculation of the maximum permissible dose of those occupationally exposed. The Commission wishes to emphasize that "medical exposure" refers to the exposure of *patients* that is necessary for medical purposes and *not* to the exposure of the personnel conducting such procedure.

Interpretation of Paragraph 49 (see also Paragraphs 10, 14, and 52): A calendar 13 week period may be used instead of a period of 13 consecutive weeks *if there is no reason to suppose that doses are being accumulated at grossly irregular rates.*

Addition to Paragraph 49: The following words should be added at the end of the paragraph: *"especially in the case of women of reproductive age."*

New paragraph to be added after Paragraph 51 (e): "51 (f) Where work involves exposure to β-rays of $E_{max} > 2.5$ Mev, eye shields or other suitable shielding may be necessary to keep the dose in the lens within permissible limits. In the case of exposure to β-rays of lower energy, if the provision of such shielding is impracticable, the small additional β-ray dose in the lens over the dose already permitted for more penetrating radiations, such as γ-rays or neutrons, is permissible, provided the dose in the skin is limited to the level recommended in Paragraph 52 (a)."

Additional paragraphs regarding the application of Paragraphs 49, 51 (d), and 51 (e) to cases of internal exposure: With reference to Paragraph 49: "52 (e) One or more short term exposures to radioactive materials (together with any exposure to external radiation) within a period of thirteen consecutive weeks is considered acceptable if the total intake of radioactive material during this period does not exceed the amount that would result from intake for thirteen weeks at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II. The dose to the critical organ during the following fifty years resulting from such an intake will not exceed the quarterly limit on dose stated in the 1958 Recommendations of ICRP. These limits are (1) for the whole body and the gonads, 3 rems; (2) for the skin, thyroid and bone[2], 8 rems; (3) for other organs, 4 rems."

With reference to Paragraph 51 (d): "52 (f) In the case of an accidental high exposure to radioactive materials where the total intake of radioactive material exceeds the amount that would result from intake for one year at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II, an estimate of the intake resulting from the exposure shall be entered on the individual's record and he shall be referred to competent medical authorities for appropriate action."

With reference to Paragraph 51 (e): "52 (g) Emergency work involving exposure above permissible limits to radioactive materials shall be planned on the basis that the total intake of radioactive material during the emergency period should not exceed the amount that would result from intake for one year at the maximum levels for occupational exposure to such radioactive materials permitted by the 1959 Report of Committee II. The dose to the critical organ during the following fifty years resulting from such an intake will not exceed the maximum yearly limit on dose stated in the 1958 Recommendations of ICRP. These limits are: (1) for the whole body and the gonads, 12 rems; (2) for the skin, thyroid, and bone[3], 30 rems; (3) for other organs, 15 rems.

"When such an exposure has occurred, an estimate of the intake shall be entered in the individual's record and measures shall be taken to prevent further exposure during the period of time it would take to accumulate this intake at the constant level of occupational exposure permitted by the 1959 Report of Committee II for such materials."

Explanatory statement of Paragraphs 53 to 57 (see also Paragraphs 15, 16, 38, and 39): The size of a "group" or a "population" is a relative concept and it is often difficult to decide whether a group should be considered "large" and whether relatively small national populations should be referred to as the "whole" population with respect to exposures of which the importance depends on the size of the group exposed. The size of a group is irrelevant in the case of *individual* exposure, where groups are defined only to distinguish between individuals for whom the recommended maximum permissible doses are different for various reasons or for whom the membership of a certain group provides for more specific recommendations with regard to individual monitoring, medical examinations, and surveys of the protection conditions. In the case of, *e.g.*, average exposure, however, the "*whole*" *population* is involved and the responsibility for the interpretation of this concept will rest with national and international administrative authorities responsible for the legal application of protection requirements.

Additional section regarding exposure of individual members of the population at large (to follow after Paragraph 57): A new section, under the heading *Exposure of the Population at Large* should be added after the section headed *Exposure of Special Groups* (Paragraphs 53–57). The text to be added, referring to both external and internal exposure, reads: "The maximum total dose limit for *individuals* in the population at large (excluding those occupationally exposed and the special groups B (a) and B (b)) should be that recommended for members of the special group B (c) (cf. Paragraph 55)."

Correction to Paragraph 65: The figure "1.7" in paragraph 65 Addendum (c) is a misprint for "0.7."

Interpretation of Paragraph 68: The basis for the limits of permissible exposure of populations to man-made sources of ionizing radiations is the dose received by the various organs of the body and not the MPC-values, or other criteria by which the dose is controlled. Nevertheless, for planning purposes some guidance as given in Paragraph 68 must be available. The word "average" in Paragraph 68 refers to the concentration of radioactive nuclides, averaged over a year, in the total intake to the average person of the population.

STATEMENTS ON ITEMS NOT INCLUDED IN THE 1958 RECOMMENDATIONS

Occupational exposure of pregnant women: With regard to occupational exposure of pregnant women the Commission notes that

1. It is especially in respect of somatic damage in foetal tissues that pregnant women present a "special risk problem" in case of occupational exposure.

2. Any special recommendations for pregnant women must in practice apply to all women of reproductive age.

Occupational working hours and length of vacation: The Commission considers that with the present maximum permissible exposure levels no special treatment of radiation workers with respect to working hours and length of vacation is required.

Emergency exposure of environmental populations: This subject was discussed extensively during the Munich meetings and the Commission considers that the British Report (7) recommending criteria for acceptable levels under emergency conditions

of I^{131}, Sr^{89}, Sr^{90}, and Cs^{137} ingested in food or milk constitutes a useful and sound approach to the subject.

REFERENCES

1. Recommendations of the International Commission on Radiological Protection (Revised Dec. 1, 1954). Brit. J. Radiol., Suppl. 6. London, British Institute of Radiology, 1955.

2. Report on Amendments During 1956 to the Recommendations of the International Commission on Radiological Protection. Acta radiol. **48:** 493–495, December 1957; Radiology **70:** 261–262, February 1958; Fortschr. a. d. Geb. d. Röntgenstrahlen **88:** 500–502, April 1958.

3. Recommendations of the International Commission on Radiological Protection (Adopted Sept. 9, 1958). ICRP Publication 1. London, Pergamon Press, 1959.

4. Report of Committee II on Permissible Dose from Internal Radiation. ICRP Publication 2. London, Pergamon Press. (In press)

5. Report of Committee III on Protection Against X-Rays up to Energies of 3 MeV and β- and γ-rays from Sealed Sources. ICRP Publication 3. London, Pergamon Press. (In press)

6. Exposure of Man to Ionizing Radiation Arising from Medical Procedures; An Enquiry into Methods of Evaluation. A Report of the International Commission on Radiological Protection and International Commission on Radiological Units and Measurements. Physics in Medicine and Biology **2:** 107–151, October 1957.

7. Report to the Medical Research Council by its Committee on Protection Against Ionizing Radiations (Chairman: E. E. Pochin): Maximum Permissible Dietary Contamination After the Accidental Release of Radioactive Material from a Nuclear Reactor. Brit. M. J. **1:** 967–969, April 11, 1959.

R. M. SIEVERT,
Chairman

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[1] Mr. Binks resigned as Secretary in 1957, for health reasons. After his resignation E. E. Smith (Great Britain) served as Acting Secretary, and since Aug. 1, 1957, B. Lindell (Sweden) has served as Temporary Secretary.

[2] Based on body burden of 0.1 microcurie of Ra^{226} (see Report of Committee II).

[3] Based on body burden of 0.1 microcurie of Ra^{226} (see Report of Committee II).

Recommendations of International Commission for Stage Grouping and for Presentation of Results

1. An international clinical stage-grouping of tumors is of paramount necessity.

2. The TNM-system[1], which was presented in 1953 to the VII International Congress of Radiology by the I.C.P.R. under the presidency of Prof. Dr. Heyman, Sweden, is accepted generally today and has been used first for carcinoma of the breast and larynx. In future this system will be in use for classification of carcinoma of the natural openings of the body, of the metastasizing tumors of the skin, and for carcinoma of the bronchus.

3. A classification according to the TM-system is recommended for tumors of the uterus, cancer of the intestinal tract, the gallbladder, the pancreas, the kidneys, and the urinary bladder.

4. The T-system is recommended for nonmetastasizing (semimalignant) tumors.

5. In cases of unknown primary tumors there is only the M-system which can be used.

6. In future a closer cooperation between the I.C.P.R. and the Committee of Nomenclature and Statistics of the U.I.C.C., the representatives of the International Committees of surgeons and gynaecologists and the World Health Organization (WHO) is to be wished.

PROF. DR. H. R. SCHINZ,
Chairman

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[1] T. Tumor. N. Lymph nodes. M. Metastases. See Schinz, H. R., and Wellauer, J.: Das TNM-System bei den wichtigsten Krebslokalisationen und dessen Ausbau. Fortschr. a. d. Geb. d. Röntgenstrahlen **91:** 89–117, July 1959. Also Carling, Windeyer, and Smithers: Practice in Radiotherapy. St. Louis, C. V. Mosby Co., 1955. p. 503.

ANNOUNCEMENTS AND BOOK REVIEWS

GREATER CINCINNATI RADIOLOGICAL SOCIETY

Newly elected officers of the Greater Cincinnati Radiological Society are Warner A. Peck, M.D., President; Eli Rubenstein, M.D., Vice-President; Stanley J. Lucas, M.D., Provident Bank Building, Cincinnati 2, Secretary.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY

The following officers were recently elected by the Radiological Society of Greater Kansas City: President, Samuel B. Chapman, Jr., M.D.; Secretary, Gerhard W. Schottman, M.D., 4400 J. C. Nichols Parkway, Kansas City, Mo.

SOCIETY OF NUCLEAR MEDICINE

The Seventh Annual Meeting of the Society of Nuclear Medicine will be held at Estes Park, Colo., June 22–25, 1960. Thad P. Sears, M.D., VA Hospital, Denver, Colo., is Chairman of the meeting.

COURSE IN CLINICAL USE OF RADIOACTIVE ISOTOPES

A course in the clinical use of radioactive isotopes will be given under the supervision of Dr. Sergei Feitelberg and Dr. Edith Quimby of the Department of Radiology, Columbia University, New York City, from June 6 through July 1, 1960. This is a full-time course which includes lectures, experimental laboratory exercises, clinical rounds, and clinical measurements on patients and on specimens. In addition to Dr. Feitelberg and Dr. Quimby, the teaching staff includes sixteen invited lecturers from the New York area, each presenting material in his own special field.

Lectures: Topics include physics of radioactive isotopes, interaction of radiation and matter, and technics of measurement of radiation and of radioactive isotopes. Clinical uses of radioactive iodine, phosphorus, and gold will be presented in detail; special lectures will cover miscellaneous diagnostic studies with radioactive iron, sodium, chromium, and other elements. Organization of isotope work in a hospital will be developed from a practical point of view.

Laboratory Work: Thirteen afternoons are devoted to experiments on basic methods of radioisotope measurements, technics used in clinical studies, and experience with actual clinical procedures.

Enrollment in the class is limited to 20; the fee is $300.

Inquiries should be addressed to Dr. Sergei Feitelberg, Mt. Sinai Hospital, Fifth Avenue at 100th Street, New York 29, N. Y.

UNIVERSITY OF CINCINNATI FELLOWSHIPS IN RADIOLOGY

The Department of Radiology of the University of Cincinnati College of Medicine and the Cincinnati General Hospital is offering three fellowships as follows:

1. In therapeutic radiology, for radiologists who have completed their formal residency training. The appointment is for one year with a stipend of $6,000.

2. In the field of radiobiology, radioisotopes, and radiological research technics. This fellowship is offered to physicians who have completed their formal residency training and is not restricted to radiologists. The appointment is for one year with a stipend of $6,000.

3. A fellowship with a stipend of $2,000 open to physicians who have completed internship or some part of their residency training. This is designed to acquaint the Fellow with research technics utilizing radioisotopes and other radiation sources.

The latter two fellowships are currently available, and new openings will occur on July 1, 1960. The fellowship in therapeutic radiology will be available at that time. Interested physicians should communicate with the Department of Radiology, University of Cincinnati College of Medicine, General Hospital, Cincinnati 29, Ohio.

AWARD TO AMERICAN COLLEGE OF RADIOLOGY

National recognition for an educational program in radiation protection has been awarded the American College of Radiology. An Award of Merit was presented to the College by the American Society of Association Executives at its Annual Meeting, Nov. 15–22, 1959, in Boca Raton, Fla. Dr. Russell D. D. Hoover, West Palm Beach, Fla., President of the Florida Radiological Society, received the award, representing the College.

POINT-SOURCE GAMMA RAY STANDARDS

The National Bureau of Standards is making available for the first time point-source standards of radioactivity. These standards are gamma-ray emitters and will be useful to research workers in approximating "ideal" conditions when calibrating scintillation counters and other beam-detecting devices.

Five of these standards are being issued under the Bureau's program to supply standards in all areas of the physical sciences. They are sodium-22, zinc 65, niobium 95, strontium 85, and mercury 203. Each standard consists of radioactive material

deposited between two layers of a thin polyester tape.

The activity of each of the nuclides distributed in this form is approximately 5×10^4 gamma rays per second. Sodium 22, which has a half-life of 2.6 years, emits a gamma ray of 1.28-Mev energy, an annihilation gamma ray of 0.511 Mev energy, and x-radiation characteristic of neon. Zinc 65, with a forty-five-day half-life, gives off a 1.11-Mev gamma ray, an annihilation gamma ray of 0.511 Mev, and x-rays characteristic of copper. Strontium 85 emits a gamma ray with an energy of 0.513 Mev and x-radiation characteristic of rubidium. Its half-life is sixty-five days. Niobium 95, which has a half-life of thirty-five days, emits a 0.768-Mev gamma ray. Mercury 203, with a half-life of 46.5 days, emits a 0.279-Mev gamma ray and x-radiation characteristic of thallium.

Further information is contained in *Standard Materials*, NBS Circular 552 (3rd edition), which may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents.

NATIONAL BUREAU OF STANDARDS NEW PUBLICATION

The National Bureau of Standards announces the publication of *X-ray Attenuation Coefficients from 10 kev to 100 Mev*, by Rosemary T. McGinnes, as a supplement to National Bureau of Standards Circular 583. The main tables in this supplement are intended to replace the low-energy portions of the tables in the original Circular.

The 10-page pamphlet may be purchased for 15 cents from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Foreign remittances must be in U. S. exchange and should include an additional one-fourth of the publication price to cover mailing costs.

CARDIOVASCULAR GRADUATE PROGRAM BOWMAN GRAY SCHOOL OF MEDICINE

The Cardiovascular Graduate Training Program of the Bowman Gray School of Medicine, Winston-Salem, N. C., will begin its second year of operation July 1, 1960, providing an integrated program in both basic science and clinical disciplines. The program is open to persons holding a Bachelor's, Master's, or Doctor's degree who wish additional training in the cardiovascular field.

Further information is available from Harold D. Green, M.D., Chairman, Department of Physiology and Pharmacology, The Bowman Gray School of Medicine, Winston-Salem 7, N. C.

NATIONAL CANCER CONFERENCE

The Fourth National Cancer Conference will be held in Minneapolis, Minn., Sept. 13–15, 1960. The main theme of the Conference will be "Changing Concepts Concerning Cancer." Further information regarding the conference may be obtained from Harry M. Nelson, M.D., 3011 W. Grand Blvd., Detroit 2, Mich.

CANCER SEMINAR SAN JUAN, PUERTO RICO

The annual Cancer Seminar of the Penrose Cancer Hospital, devoted this year to soft-tissue lesions, will be re-enacted in Puerto Rico on March 16, 1960. Dr. Arthur P. Stout will be the pathologist; Dr. Charles Eckert, the surgeon; Dr. Philip Hodes, the radiologist; Dr. Juan del Regato, the moderator.

The Puerto Rico Society of Pathologists is sponsoring this Seminar as part of a two-day program. Additional information may be obtained from Dr. Raúl A. Marcial-Rojas, University of Puerto Rico, San Juan, Puerto Rico.

THIRD INTERNATIONAL CONFERENCE ON MEDICAL ELECTRONICS

The Third International Conference on Medical Electronics will be held in London, July 21–27, 1960. The Meeting is being organized by the Electronics and Communications Section of the Institution of Electrical Engineers and the International Federation for Medical Electronics.

The Organizing Committee is soliciting papers on the following subjects: instrumentation for biological needs; medical electronics in space research; isotopes and radiology; ultrasonics; the respiratory system; the digestive system; the circulatory system; electronic aids to sight, hearing, and locomotion; the nervous system; electronic aspects of human engineering. Papers should be brief, in general not exceeding 2,500 words, dealing with practical problems encountered in the operation of equipment or with limited aspects of a wide subject.

Authors from the United States who wish to submit manuscripts or who have questions about the International Conference should write to the Program Coordinator for this country, Lee B. Lusted, M.D., Department of Radiology, University of Rochester School of Medicine, Rochester 20, N. Y. The deadline for papers is Feb. 15, 1960.

MEMORIAL RADIOLOGICAL COLLECTION UNIVERSITY OF PITTSBURGH

The Pennsylvania Radiological Society has established a memorial collection in radiology at the Falk Library, University of Pittsburgh. The collection was initiated with a gift of books by Dr. Gerald D. Bliss, Altoona, first president of the Society. Through the efforts of Dr. Lewis E. Etter of Pittsburgh and others, the Society has pledged an annual contribution to permit the continued addition of new materials to the collection.

AMERICAN SOCIETY OF X-RAY TECHNICIANS

The American Society of X-Ray Technicians will hold its Thirty-second Annual Convention at the

Netherland Hilton Hotel, Cincinnati, Ohio, June 11–16, 1960. The General Chairman of the Convention Committee is Roland C. McGowan, R.T., Christ Hospital, Cincinnati 19, Ohio.

Letters to the Editor

To the Editor of Radiology

DEAR DR. DOUB:

For some time now, a number of radiologists have been expressing dissatisfaction with academic radiologists who are presenting courses in diagnostic roentgenology to general practitioners. It would seem that a better understanding by all concerned would result if the subject were brought into the open.

The expressions of alarm have come from sincere and honest individuals who feel that offering this meager radiological training to general practitioners will encourage them to extend their activities in a field where they are dangerously unqualified. It is pointed out that, at least in most instances, adequate diagnostic roentgen facilities are available from trained radiologists and there is, therefore, little need for the general practitioner to make roentgen interpretations. They add that only a smattering of roentgenology can be taught the nonradiologist in the allotted time. The necessary oversimplification would encourage those who do not already have x-ray equipment to purchase it, and those who do have it to feel qualified to attempt roentgen examinations and interpretations which are beyond their limited capabilities.

This point of view is not shared by a number of academicians. It has long been the established policy of many university departments to attempt to provide instructions to *any* physician who seeks it, within the limits of available time and facilities. The door often stands open to anyone who wishes to attend teaching exercises or to observe roentgen interpretation or fluoroscopy. Courses in chest fluoroscopy have been designed for medical residents and, on occasion, courses in roentgen interpretation and individual lectures on a variety of radiological topics have been given to the generalist.

To justify this side of the controversy, the following points are emphasized:

1. Roentgenology affords an excellent visual method of teaching—and remembering—general medical subjects. Individuals schooled in visual aid methods agree that most minds retain a picture image better than a word description. Furthermore, the varied manifestations of certain diseases, as for example scleroderma, fall under multiple specialties, and the student seldom gets the opportunity to gain an understanding of the entire subject from any one teacher. The radiologist, crossing the lines between other specialties, can often make a clearer and more cohesive presentation of these overlapping diseases than any other specialist. Courses for general practitioners should be primarily directed toward the teaching of medical subjects through the medium of roentgenology.

2. A number of practitioners in smaller communities already possess and use roentgen equipment and make roentgen interpretations. Since a radiologist is seldom available in these places, there is some justification for this. It is more difficult to rationalize the x-ray unit in the office of the general practitioner in the city, where radiologic services are readily at hand. It should be emphatically stated that there are serious objections to the practice of roentgenology by physicians untrained in this field. The frequency and gravity of their errors have been appalling. Nonetheless, we must face the fact that there are many more operating x-ray units in the offices of general practitioners than there are in the offices of trained radiologists and that there are insufficient radiologists today to handle properly all the radiological work. There is no valid reason to believe that attendance at postgraduate courses will *adversely* affect the quality of the roentgenology the private practitioner is already performing. In fact, a properly designed course in diagnostic roentgenology should make him realize his inadequacy and encourage him to refer more patients to the roentgenologist than he is now doing.

3. The practice of withholding medical knowledge because of fear of what the recipient might do with it is a dangerous one. Where should the line be drawn? Certainly no one would advocate curtailment of our medical school or resident teaching on this account. But one can readily see the harm that would ensue if the dermatologist refused to teach the general practitioner to recognize the commoner skin conditions, the orthopedist withheld his knowledge and experience in the fracture field, the surgeon failed to instruct him in the early recognition of appendicitis and the internist to train him in antibiotic therapy. The hope of medicine is in selection: selection of honorable and dedicated individuals to become physicians. We must not penalize the many ethical practitioners in an almost futile effort to thwart the dishonest few.

The American Society of General Practitioners has taken cognizance of these facts by setting up a highly commendable system of mandatory postgraduate credits. The Hippocratic oath also deals succinctly and clearly with this subject: "By precept, lecture and every other mode of instruction, I will impart a knowledge of the art to my own sons and to those of my teachers, and to disciples bound by stipulation and oath, according to the law of medicine, but to none others." In similar vein, The Principles of Medical Ethics of the American Medical Association reads: "Physicians . . . share whatever they have learned and whatever they may discover with their colleagues in every part of the globe. They recognize instinctively that the need for improvement of medical knowledge and skills is never at an end, and while they strive toward satis-

faction of this need they are zealous in making available to physicians of good character who possess the desire and the ability to learn, the aggregate of progress in medical education, research, and discoveries as they may exist at the time."

For these reasons I sincerely believe the teacher of radiology, as a representative of his profession, his medical college, and his specialty, must be willing —where time and facilities permit—to impart as much of his knowledge as he can to any physician or group of physicians seeking it.

Yours sincerely,
BENJAMIN FELSON, M.D.
Cincinnati, Ohio

To Dr. Howard P. Doub
Editor of Radiology

DEAR SIR:

In co-operation with the World Health Organization, the International Atomic Energy Agency recently organized a Study Group on the Use of Radioisotope Teletherapy and Supervoltage Radiation in Radiotherapy. At a meeting held Aug. 3–4, in Vienna, experts from twelve countries took part in the discussion. In view of the rapid development of teleisotope therapy, the Study Group directed its main attention to formulating recommendations on the basic requirements in supervoltage radiotherapy, with a view to providing guidance especially to those areas where radiotherapy is not yet firmly established.

Plans are being made to print the Report of this meeting later this year, together with some background information prepared by the Agency. It is believed that many of the recommendations will be of considerable interest to those working in this field. Inquiries as to the final Report may be addressed to the undersigned. Yours sincerely,

K. C. Tsien
Scientific Secretary to the Study Group
Department of Research and Isotopes
International Atomic Energy Agency
Vienna 1, Kaerntnerring, Austria

In Memoriam

DAVID M. GHRIST, M.D.

1865–1959

Dr. David M. Ghrist, one of the early members of the Radiological Society of North America (1920), died at the age of ninety-four, Nov. 14, 1959, in Glendale, Calif. Dr. Ghrist was born in Marion County, Iowa, was graduated from Keokuk Medical College, and with his wife, Dr. Jennie Ghrist, practiced medicine in Ames, Iowa, from 1898 to 1925. In the latter year he moved to Glendale, California, where he was active in both private and hospital practice of radiology until his retirement in 1949. On the occasion of his seventy-fifth birthday, Dr. Ghrist was honored by the American College of Radiology, which awarded him its first honorary membership emeritus plaque.

Surviving Dr. Ghrist are a son, Dr. Orrie Ghrist, a grandson, Dr. William Ghrist, and two other grandchildren. A second son, Dr. David Ghrist, died in 1937.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

RADIOLOGIC EXAMINATION OF THE SMALL INTESTINE. By ROSS GOLDEN, M.D., Visiting Professor of Radiology, University of California at Los Angeles; Professor Emeritus of Radiology, Columbia University; formerly, Director of Radiology, The Columbia-Presbyterian Medical Center, New York City. A volume of 560 pages, with 176 figures. Published by Charles C Thomas, Springfield, Ill., 2d ed., 1959. Price $28.50.

ANNUAL REVIEW OF NUCLEAR SCIENCE. VOLUME 9. Co-editors: EMILIO SEGRÈ, University of California, AND LEONARD I. SCHIFF, Stanford University. Associate Editors: GERHART FRIEDLANDER, Brookhaven National Laboratory, AND WALTER E. MEYERHOF, Stanford University. A volume of 626 pages, with numerous figures and tables. Published by Annual Reviews, Inc., in co-operation with the National Research Council of the National Academy of Sciences, 1959. On sale by Annual Reviews, Inc., Palo Alto, Calif. Price $7.00 (U. S. A.); $7.50 elsewhere.

THE ROENTGENOGRAPHIC SLIT METHODS: A SURVEY AND ANALYSIS OF PROCEDURES BASED ON THE USE OF A NARROW BUNDLE OF ROENTGEN RAYS (SCANOGRAPHY). By PEKKA VUORINEN. From the Department of Roentgenology, University Central Hospital, Turku, Finland, and the Wenner-Gren Research Laboratory, Norrtulls Sjukhus, Stockholm, Sweden. Suppl. 177 to Acta radiologica. A monograph of 88 pages, with 42 figures and 5 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 25:—.

DETERMINATION OF CELL MASS BY DIRECT X-RAY ABSORPTION. By BENGT H. O. ROSENGREN. From the Departments of Radiotherapeutics, Konung Gustaf V:s Jubileumsklinik, Radiophysics, and Histology, University of Gothenburg,

Sweden. Suppl. 178 to Acta radiologica. A monograph of 62 pages, with 24 figures and 4 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 25:—.

KILOCURIE COBALT 60 THERAPY AT THE RADIUMHEMMET: EQUIPMENT, TECHNIQUE AND DOSE MEASUREMENTS. By S. HULTBERG, O. DAHL, R. THORAEUS, K. J. VIKTERLÖF, AND R. WALSTAM. From Radiumhemmet and the Institute of Radiophysics, Karolinska Sjukhuset, Stockholm 60, Sweden. Suppl. 179 to Acta radiologica. A monograph of 286 pages, with 63 figures, 135 charts, and 13 tables. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 35:—.

MOTOR ACTIVITY OF THE STOMACH. By BENGT LILJA. From the Roentgen Department, Centrallasarettet, Halmstad, Sweden. Suppl. 180, to Acta radiologica. A monograph of 94 pages, with 32 figures. Published by Acta radiologica, Stockholm 2, Sweden, 1959. Price Sw. Kr. 25:—.

ELECTRICAL IMPEDANCE PLETHYSMOGRAPHY: THE ELECTRICAL RESISTIVE MEASURE OF THE BLOOD PULSE VOLUME, PERIPHERAL AND CENTRAL BLOOD FLOW. By JAN NYBOER, D.Sc., M.D., Chief, Division Cardiovascular Physiology Research; Electrocardiographer and Associate Physician, Department of Medicine, Harper Hospital, Detroit, Mich.; Professor, Department of Physiology and Pharmacology, Wayne State University Medical School, Detroit, Mich. With a Foreword by Franklin D. Johnston, B.S. (Eng'g), M.D. A volume of 244 pages, with 104 figures. Published by Charles C Thomas, Springfield, Ill., 1959. Price $7.50.

DIAGNOSE UND DIFFERENTIALDIAGNOSE IN DER SCHÄDELRÖNTGENOLOGIE. By Prof. Dr. ERNST G. MAYER, Vorstand des Zentral-Röntgeninstitutes (Guido-Holzknecht-Institut) der Universität Wien. A volume of 600 pages, with 584 illustrations on 376 figures with legends in German, English, Spanish, and French. Published by Springer-Verlag, Mölkerbastei 5, Vienna 1, Austria, 1959. Price $46.20.

DIAGNOSTICA RADIOLOGICA DELLE VIE BILIARI. By T. BRAIBANTI, L. ROSSI, AND A. MAESTRI, Istituto di radiologia dell'Università di Parma. Foreword by Prof. E. Benassi. A volume of 494 pages, with 183 figures. Published by Minerva medica, Turin, Italy, 1958.

Book Reviews

DENTAL ROENTGENOLOGY. By LEROY M. ENNIS, D.D.S., F.D.S., R.C.S. (Eng.), Chairman of the Department of Roentgenology, and Professor of Roentgenology, The Thomas W. Evans Museum and Institute, School of Dentistry, University of Pennsylvania; Chairman of the Department of Oral Roentgenology, and Professor of Oral Roentgenology, The Graduate School of Medicine, University of Pennsylvania; Consultant in Dental Roentgenology, U. S. Navy, U. S. Army, and U. S. Veterans Administration Hospital, Coatesville, Penna.; and HARRISON M. BERRY, JR., D.D.S., M.Sc., Professor of Roentgenology, The Thomas W. Evans Museum and Institute, School of Dentistry, University of Pennsylvania; Associate Professor of Oral Roentgenology, Graduate School of Medicine, University of Pennsylvania; Director, Courses in Oral Hygiene, School of Dentistry, University of Pennsylvania; Chief, Dental Roentgenology, Philadelphia General Hospital; Area Consultant, Dentistry, U. S. Veterans Administration; Civilian Consultant in Dental Roentgenology, U. S. Naval Hospital, Philadelphia, and Valley Forge Army Hospital. A volume of 608 pages, with 1,282 illustrations. Published by Lea & Febiger, Philadelphia 6, Penna., 5th ed., 1959. Price $15.00.

The authors have attempted to produce a book which covers the entire subject of dental roentgenology, including the production of x-rays, the dangers of radiation, the processing of the films, and their ultimate analysis in terms of pathology. While they have written primarily for the dental profession, their text contains much of value for medical radiologists.

The first third of the book is devoted largely to technical matters which are of limited interest to skilled radiologists. A chapter on the normal anatomy of the teeth and jaws as shown on the roentgenogram is a valuable one. Succeeding chapters are devoted to the temporomandibular articulation and to dental pathology in relation to roentgenology. They are clearly written and authoritative. One chapter discusses the chemistry of calcification, and another malignant tumors.

The text is profusely illustrated with almost 1,300 figures, comprising photographs, radiographs and line drawings. References are appended to some of the chapters. An Index concludes the book.

This volume is a valuable one for the dental profession and should find a place, also, in the library of the medical radiologist who is called upon to give opinions on radiographs of the jaws and teeth.

PRINCIPLES OF RADIATION DOSIMETRY. By G. N. WHYTE, National Research Council, Ottawa, Canada; Queen's University, Kingston, Ontario. A monograph of 124 pages, with numerous figures and tables. Published by John Wiley & Sons, Inc., New York 16, N. Y., 1959. Price $7.00.

The aim of this book is to present the basic concepts of radiation dosimetry in their relation to

determination of quantity and quality, which doubtless accounts for the absence of practical discussions of procedures. The brevity of the text and lack of detail lessen the value of the work to the beginner in the field, while the elementary nature of its discussions make it useless to the experienced reader. The author states in his preface that "the book is intended primarily for the science graduate faced with the problem of determining radiation dose." It has little to offer the working radiological physicist or radiologist.

RADIATION BIOLOGY AND MEDICINE: SELECTED REVIEWS IN THE LIFE SCIENCES. Edited by WALTER D. CLAUS, Division of Biology and Medicine, U.S.A.E.C. Prepared for the United States Atomic Energy Commission. A volume of 944 pages, with numerous figures and tables. Published by Addison-Wesley Publishing Company, Inc., Reading, Mass., 1958. Price $11.50.

This is a collection of 33 carefully selected reviews of various aspects of radiation as related to medical, biological, and agricultural uses. An interesting and logical arrangement of the reviews has been followed. Thus, in the section on Basic Mechanisms of Biological Reaction to Radiation, a review on basic physical and chemical mechanisms of reaction to radiation introduces that on cellular effects, which in turn is followed by organ and organism response, and finally by species response. Each topic is organized in a similar manner, the consideration of mutations beginning at the chromosome level and ending with genetic damage in populations. The relationship between injury and recovery starts at the cellular level and includes the entire animal. In this connection the whole body syndrome is described, leading to maximum permissible dose and hazard evaluation.

Medical and agricultural uses of radioisotopes are described, and their diagnostic and experimental uses in tracer amounts are reviewed. The applications of mathematics to biology are given, including the role of the information theory. The book closes with a brief description of instrumentation.

As is unavoidable in an attempt to cover so wide a field in so small a space, details are largely omitted. However, extensive bibliographies guide the interested reader in further study. The various authors are to be congratulated on their job of summarizing and correlating the vast amount of work in their respective fields. The book will be of great interest and assistance to anyone concerned with the action of radiation on living material.

BASIC PHYSICS IN RADIOLOGY. By L. A. W. KEMP, B.Sc., Ph.D., F.Inst.P., Chief Physicist to the London Hospital, AND R. OLIVER, M.Sc., F.Inst.P., A.M.I.E.E., Principal Physicist in the Department of Radiotherapy of the United Oxford Hospitals, Oxford, England. A volume of 330 pages, with 143 figures. Published by Charles C Thomas, Springfield, Ill., 1959. Price $8.50.

The material covered by this book is limited to the fundamental principles of physics as these apply to radiology. It is meant to precede or accompany the usual textbook for radiological residents or technicians. Examples and illustrations are drawn, whenever possible, from radiology. Mathematics is kept to a minimum.

The book could be used to advantage as a reference book on subjects on which the student of radiological physics requires further elucidation beyond that given in the usual text.

COUPES HORIZONTALES DU TRONC: ATLAS ANATOMIQUE ET RADIOLOGIQUE À L'USAGE DES CHIRURGIENS ET DES RADIOLOGISTES. By RAYMOND ROY-CAMILLE, Prosecteur à la Faculté de Médecine de Paris. Preface by Prof. Gaston Cordier. A volume of 122 pages, with 54 roentgenograms and 54 diagrams. Published by Masson & Cie, 120 Boulevard Saint-Germain, Paris VI°, France, 1959. Price 8,000 fr.

This fine atlas is made up of 54 horizontal sections of the body less than 1.0 cm. thick, extending from C-4 to the coccyx. Each section has been radiographed, and line drawings clearly indicate the anatomic parts. The work is designed to present anatomic detail, as only transverse cuts can do, and to aid specifically in the interpretation of transverse stratigraphy. The atlas should therefore be of value to students and surgeons, as well as radiologists.

The physical characteristics of the book are beyond reproach. It can be recommended without qualification.

TUMEURS BÉNIGNES DES OS ET DYSTROPHIES PSEUDOTUMORALES. By ANDRÉ TRIFAUD, Professeur agrégé à la Faculté de Médecine de Marseille, Chirurgien des hôpitaux, AND HENRI BUREAU, Interne des Hôpitaux de Marseille. With the collaboration of HENRI PAYAN, Professeur agrégé d'anatomie pathologique à la Faculté de Médecine de Marseille. Preface by Professor Michel Salmon. A volume of 280 pages, with 136 figures. Published by Masson & Cie, 120 Boulevard Saint-Germain, Paris VI°, France, 1959. Price 4,200 fr.

In this monograph on benign bone tumors and pseudotumors, the authors provide a rather thorough discussion of the subject, with good illustrations of the roentgenographic and histopathologic findings. The lesions are discussed from the standpoint of their site of origin and their radiographic nature. For example, cartilaginous, vascular, nervous, and other tissues of origin are considered, whereas some lesions are separated into osteoblastic and osteolytic types for purposes of discussion. Among

conditions similar to benign bone lesions which are included are aneurysmal bone cysts, brown tumors of hyperparathyroidism, xanthomatoses, and cystic lesions of bone.

RADIODIAGNOSTIC EN OTOLOGIE. By MICHEL PORTMANN, Professeur agrégé à la Faculté de Médecine de Bordeaux, AND GEORGES GUILLEN, Chef de Clinique à la Faculté de Médecine de Bordeaux. Preface by Prof. Georges Portmann de la Académie Nationale de Médecine. A volume of 210 pages, with 146 figures. Published by Masson & Cie, 120 Boulevard Saint-Germain, Paris VI°, France, 1959. Price 3,700 fr.

This new book on otologic radiodiagnosis is largely a study of classical and modern technics. Relying on a clinical experience of many years, the authors feel the necessity of making a choice among the numerous procedures and to propose the most fruitful plan of examination. They rely mostly on three methods: The Schüller technic, the transorbital technic of Guillen, and technic III of Chaussé. They believe that, with the help of these technics, one can study as perfectly as possible the middle ear and the labyrinth. However, complementary methods will be required in certain cases, in particular the Stenvers and Hirtz technics and tomography.

The latter half of the book deals with the pathology of the middle ear. Successively considered are: malformations, trauma, acute and chronic infections, tumors of the middle ear (tumors of the internal auditory canal and of the pontocerebellar region are not considered here), otodystrophies and radiological examination of the eustachian tube.

This beautiful book is clearly written, easy to consult, and practical.

TRAUMATISMES ANCIENS: RACHIS, MEMBRE INFÉRIEUR. By MERLE D'AUBIGNÉ, Professeur de Clinique chirurgicale orthopédique et réparatrice à la Faculté de Médecine de Paris, AND J.-O. RAMADIER, Professeur agrégé d'Orthopédie à la Faculté de Médecine de Paris. With the collaboration of J. Cauchoix, J. Duparc, J.-P. Lamare, A. Lemoine, P. Masse, R. Méary, M. Postel, Cl. Toubeau, O. Troisier, and R. Tubiana. A volume of 546 pages, with 218 figures. Published by Masson & Cie, 120 Boulevard Saint-Germain, Paris VI°, France, 1959. Price 7,500 fr., paper-bound; 8,500 fr., cloth-bound.

This book is one of a series under the supervision of the senior author, whose work on lesions of the upper extremity was reviewed in an earlier issue of RADIOLOGY (**72:** 281, 1959). Fractures, subluxations, and dislocations of the various portions of the spine are covered, and old injuries and avascular necrosis in the region of the hip are considered in great detail. Severe deformities after healing of fractures in abnormal positions and pseudarthroses receive extensive attention. Several types of knee injuries with reproduction of arthrograms constitute a rather good coverage of the region.

As in the monograph cited above, the emphasis is on orthopedic treatment but there are several roentgenographic reproductions and for the radiologist who needs a little more understanding of orthopedic problems of the spine and lower extremity the work will prove valuable for reference.

DOSIMETRIE UND STRAHLENSCHUTZ: PHYSIKALISCHE UND TECHNISCHE DATEN. By Prof. Dr. R. G. JAEGER, Braunschweig and Mainz. A volume of 282 pages, with 97 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 49.50.—($11.80).

We have here an excellent work of reference for any radiologist, physicist, engineer, or technician working with radioactive material and x-rays. In addition to general tables and charts for abbreviations and conversion factors, there are definitions of physical units and important physical constants. Extensive information is furnished in the form of charts, tables, and short explanations, covering ionization, radioactivity, dosimetry, corpuscular radiation, roentgen and gamma rays, and radiation protection. References are given covering rules and regulations for protection for many countries.

The author's reputation is an assurance that the collection of data presented in this book is as complete as possible in the fast-growing field of radiation physics. In utilizing charts and tables, he has put into abbreviated form the very essential facts needed for rapid evaluation. Furthermore, his brief text is written with the same thought in mind. Supporting this, is the good editing of the book. The numerous references include many American and English contributions.

DAS DIAGNOSTISCHE PNEUMOPERITONEUM. By PROF. DR. MED. A. GEBAUER, Frankfurt am Main. With a Foreword by Prof. Dr. F. Hoff, Direktor der I. Medizinischen Universitätsklinik, Frankfurt am Main. A monograph of 70 pages, with 78 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 18.—($4.30).

This monograph is based on the author's experience with over 1,100 diagnostic pneumoperitoneums. Historical, technical, and clinical considerations are discussed. With careful technic, few complications have been encountered. Anteroposterior and lateral views are taken with the patient upright and supine, and a lateral view in the prone position. In women the pelvic organs may be demonstrated by

elevating the pelvis before taking roentgenograms of the region.

Differentiation of eventration from diaphragmatic hernia, demonstration of abdominal adhesions, cirrhosis, and metastases of the liver, demonstration of an enlarged gallbladder, pancreas, or spleen all serve as indications for the procedure. Valuable information may also be secured in the study of tumors of the female pelvis.

DIE PHLBEOGRAPHIE DER UNTEREN EXTREMITÄT. By DR. ROBERT MAY, Innsbruck, and DR. RAIMUND NISSL, Innsbruck. Fortschr. a. d. Geb. d. Röntgenstrahlen, Ergänzungsband 84. A volume of 198 pages, with 395 illustrations on 250 figures. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Distributed in United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y. Price DM 75.—($17.85); to subscribers to Fortschritte, DM 67.50.—($16.05).

This is a very thorough treatise on phlebography of the lower extremity with a chapter on veins of the pelvis also included. Anatomy, technic of examination, and contrast agents are presented. Venous thrombosis, development of collaterals, the postphlebitic syndrome, vascular anomalies, and tumors are described. Numerous line drawings and photographs accompany very good roentgenographic reproductions.

RADIOLOGIA CLINICA DELLE CALCIFICAZIONI ENDOCRANICHE. By Giovanni Baldini, Specialista in Radiologia e Neuropsichiatria, Clinica Neurologica dell'Università di Pavia, and Luigi Roncoroni, Specialista in Radiologia, Istituto di Radiologia dell'Università di Milano. A volume of 392 pages, with 169 figures. Published by Casa Editrice Ambrosiana, Via G. Bertacchi, 7, Milan, Italy, 1959.

This rather exhaustive monograph on intracranial calcifications as studied radiographically is the work of two radiologists, one of whom is also a neurologist. The book is divided into three parts. The first or general part goes into the biochemical basis of heterotopic calcification. An original classification of intracranial calcifications is given, which is later followed through the monograph. A brief description of the radiographic technic used by the authors is also presented.

Part II deals with asymptomatic intracranial calcifications. Good illustrations of calcifications of the pineal, habenula, dura, and choroid plexus are given.

Part III of the book is by far the best. It deals with pathologic calcifications. Illustrations and a very informative text with statistical and descriptive data are given on meningomas, gliomas, intra- and juxta-sellar tumors. Ependymal and choroid tumors are also discussed, and there are sections on lipomas of the corpus callosum and metastatic tumors; a short chapter dealing with calcifications in intracranial tumors in infancy and adolescence; and chapters on calcifications caused by parasites or of infectious origin. Hemorrhagic calcifications, vascular calcifications and calcifications in vascular tumors, and malformations are also dealt with, as are calcifications in Sturge-Weber-Krabbe disease and tuberous sclerosis. The final chapter on intracranial calcifications of uncertain origin, includes calcifications in epilepsy, calcifications of the basal nuclei, and cerebral calculi.

The text is written well and concisely. The bibliography is complete. The illustrations, although positive, are of excellent quality and in the majority of instances exhibited side-by-side with schematic drawings. The legends are informative.

This book is highly recommended for radiologists whose work load includes a significant amount of craniology.

RADIOLOGICAL SOCIETIES: SECRETARIES AND MEETING DATES

Editor's Note: Secretaries of state and local radiological societies are requested to co-operate in keeping this section up-to-date by notifying the editor promptly of changes in officers and meeting dates.

RADIOLOGICAL SOCIETY OF NORTH AMERICA. *Secretary-Treasurer*, Donald S. Childs, M.D., 713 E. Genesee St., Syracuse 2, N. Y.

AMERICAN RADIUM SOCIETY. *Secretary*, Robert L. Brown, M.D., Robert Winship Clinic, Emory University, Atlanta 22, Ga.

AMERICAN ROENTGEN RAY SOCIETY. *Secretary*, C. Allen Good, M.D., Mayo Clinic, Rochester, Minn.

AMERICAN COLLEGE OF RADIOLOGY. *Exec. Secretary*, William C. Stronach, 20 N. Wacker Dr., Chicago 6.

AMERICAN CLUB OF THERAPEUTIC RADIOLOGISTS. *Secretary*, Juan A. del Regato, M.D., 2200 North Cascade Ave., Colorado Springs, Colo.

ASSOCIATION OF UNIVERSITY RADIOLOGISTS. *Secretary-Treasurer*, Paul A. Riemenschneider, M.D., 736 Irving Ave., Syracuse 10, N. Y.

SECTION ON RADIOLOGY, A. M. A. *Secretary*, T. Leucutia, M.D., 10 Peterboro, Detroit 1, Mich.

SOCIETY OF NUCLEAR MEDICINE. *Secretary*, Robert W. Lackey, M.D., 452 Metropolitan Bldg., Denver 2, Colo.

Alabama

ALABAMA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Garland Wood, Jr., M.D., Medical College of Alabama, Birmingham 3.

Arizona

ARIZONA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. Lee Foster, M.D., 1313 N. Second St., Phoenix. Annual meeting with State Medical Association; interim meeting in December.

Arkansas

ARKANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. B. Scruggs, M.D., 1700 W. 13th St., Little Rock. Meets quarterly.

California

CALIFORNIA MEDICAL ASSOCIATION, SECTION ON RADIOLOGY. *Secretary*, William H. Graham, M.D., 630 E. Santa Clara St., San Jose.

EAST BAY ROENTGEN SOCIETY. *Secretary*, Dan Tucker, M.D., 434 30th St., Oakland 9. Meets monthly, first Thursday, at Peralta Hospital.

LOS ANGELES RADIOLOGICAL SOCIETY. *Secretary*, Denis C. Adler, M.D., 2010 Wilshire Blvd., Los Angeles 57. Meets second Wednesday, September, November, March, April, and June, Los Angeles County Medical Association Building.

NORTHERN CALIFORNIA RADIOLOGICAL SOCIETY. *Secretary*, Rob H. Kirkpatrick, M.D., 1219 28th St., Sacramento 16. Meets last Monday of each month, September through June.

PACIFIC ROENTGEN SOCIETY. *Secretary*, L. Henry Garland, M.D., 450 Sutter St., San Francisco 8. Meets annually at time of California State Medical Association convention.

RADIOLOGICAL SOCIETY OF SOUTHERN CALIFORNIA. *Secretary*, Joseph F. Linsman, M.D., 436 N. Roxbury Dr., Beverly Hills.

REDWOOD EMPIRE RADIOLOGICAL SOCIETY. *Secretary*, Lee E. Titus, M.D., 164 W. Napa Street, Sonoma, Calif. Meets second Monday every other month.

SAN DIEGO RADIOLOGICAL SOCIETY. *Secretary*, Stanley A. Moore, M.D., 2466 First Ave., San Diego 1. Meets first Wednesday of each month.

SAN FRANCISCO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, M. A. Sisson, M.D., 450 Sutter St., San Francisco 8. Meets quarterly, at Grison's Steak House.

SOUTH BAY RADIOLOGICAL SOCIETY. *Secretary*, Stanford B. Rossiter, M.D., 1111 University Dr., Menlo Park. Meets second Wednesday every month.

X-RAY STUDY CLUB OF SAN FRANCISCO. *Secretary*, John H. Heald, M.D., 450 Sutter St., San Francisco 8. Meets third Thursday at 7:30 P.M., Children's Hospital, September through June.

Colorado

COLORADO RADIOLOGICAL SOCIETY. *Secretary*, Bertram L. Pear, M.D., 3705 E. Colfax Ave., Denver 6. Meets monthly, third Friday, at Denver Athletic Club.

Connecticut

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary-Treasurer*, Ralph J. Littwin, M.D., Bristol Hospital, Bristol. Meets bimonthly, second Wednesday.

District of Columbia

RADIOLOGICAL SECTION, DISTRICT OF COLUMBIA MEDICAL SOCIETY. *Secretary-Treasurer*, William E. Sheely, M.D., 1746 K St., N.W., Washington 6. Meets third Wednesday, January, March, May, and October, 8:00 P.M., in Medical Society Library.

Florida

FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, John P. Ferrell, M.D., 166 4th Ave., St. Petersburg.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Joseph C. Rush, M.D., Mease Hospital, Dunedin. Meets quarterly at the Tampa Terrace Hotel.

GREATER MIAMI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George P. Daurelle, M.D., Jackson

Memorial Hospital, Miami 36. Meets monthly, third Wednesday, 8:00 P.M., at Jackson Memorial Hospital.

NORTH FLORIDA RADIOLOGICAL SOCIETY. *Secretary*, Paul A. Mori, M.D., 800 Miami Road, Jacksonville 7. Meets quarterly, March, June, September, and December.

Georgia

ATLANTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Luther Clements, Jr., M.D., 35 Linden Ave., N.E., Atlanta 8. Meets second Friday, September to May.

GEORGIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George W. Brown, M.D., 317 S. 8th St., Griffin, Ga. Meets in November and at the annual meeting of the State Medical Association.

RICHMOND COUNTY RADIOLOGICAL SOCIETY. *Secretary*, Wm. F. Hamilton, Jr., M.D., University Hospital, Augusta. Meets first Thursday of each month.

Hawaii

RADIOLOGICAL SOCIETY OF HAWAII. *Secretary-Treasurer*, Louis L. Buzaid, M.D., The Queen's Hospital, Box 861, Honolulu. Meets third Monday of each month.

Idaho

IDAHO STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Charles R. McWilliams, M.D., Twin Falls.

Illinois

CHICAGO ROENTGEN SOCIETY. *Secretary-Treasurer*, George B. Cahill, M.D., 802 Burns Ave., Flossmoor, Ill. Meets at the Sheraton Hotel, second Thursday of October, November, January, February, March, and April at 8:00 P.M.

ILLINOIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George A. Miller, M.D., Carle Hospital Clinic, Urbana. Spring and Fall meetings.

ILLINOIS STATE MEDICAL SOCIETY, SECTION ON RADIOLOGY. *Secretary*, William Meszaros, M.D., 1825 W. Harrison St., Chicago.

Indiana

INDIANA ROENTGEN SOCIETY. *Secretary-Treasurer*, David E. Wheeler, M.D., 1500 North Ritter, Indianapolis. Meets twice a year, first Sunday in May and during fall meeting of State Medical Association.

TRI-STATE RADIOLOGICAL SOCIETY (Southern Indiana, Northwestern Kentucky, Southeastern Illinois). *Secretary-Treasurer*, James R. Mathews, M.D., 118 S. E. First St., Evansville, Ind. Meets October, January, March, and May.

Iowa

IOWA RADIOLOGICAL SOCIETY. *Secretary*, James T. McMillan, M.D., 1104 Bankers Trust Bldg., Des Moines. Meets during annual session of State Medical Society, and in the Fall.

Kansas

KANSAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Lewis G. Allen, M.D., 807 Huron Bldg., Kansas City, Kans. Meets in the Spring with the State Medical Society and in the Winter on call.

Kentucky

KENTUCKY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Robert H. Akers, M.D., VA Hospital, Louisville 2. Meets monthly, second Friday, at Seelbach Hotel, Louisville.

Louisiana

ORLEANS PARISH RADIOLOGICAL SOCIETY. *Secretary*, Joseph V. Schlosser, M.D., Charity Hospital of Louisiana, New Orleans 13. Meets second Tuesday of each month.

RADIOLOGICAL SOCIETY OF LOUISIANA. *Secretary-Treasurer*, Seymour Ochsner, M.D., Ochsner Clinic, New Orleans 15.

SHREVEPORT RADIOLOGICAL CLUB. *Secretary*, W. R. Harwell, M.D., 608 Travis St. Meets monthly September to May, third Wednesday.

Maine

MAINE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Edward C. Porter, M.D., Eastern Maine General Hospital, Bangor. Meets in June, October, December, and April.

Maryland

MARYLAND RADIOLOGICAL SOCIETY. *Secretary*, Albert B. Shackman, M.D., 705 Medical Arts Bldg., Baltimore 1.

Michigan

DETROIT X-RAY AND RADIUM SOCIETY. *Secretary-Treasurer*, Kenneth L. Krabbenhoft, M.D., 3825 Brush, Detroit 1. Meets first Thursday, October to May, Wayne County Medical Society rooms.

UPPER PENINSULA RADIOLOGICAL SOCIETY. *Secretary*, Arthur Gonty, M.D., Menominee. Meets quarterly.

Minnesota

MINNESOTA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Donald H. Peterson, M.D., 25 W. Fourth St., St. Paul 2. Meets Fall, Winter, and Spring.

Mississippi

MISSISSIPPI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Bernard T. Hickman, M.D., University of Mississippi Medical Center, Jackson. Meets monthly, on third Thursday, 6:00 P.M., at Hotel Edwards, Jackson.

Missouri

GREATER ST. LOUIS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Harvey A. Humphrey, M.D., 510 S. Kingshighway, St. Louis 10. Meets on fourth Wednesday, October to May.

RADIOLOGICAL SOCIETY OF GREATER KANSAS CITY. *Secretary*, Gerhard W. Schottman, M.D., 4400 J. C. Nichols Pkwy., Kansas City, Mo. Meets fourth Friday of each month October through May.

Montana

MONTANA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. K. Boughn, M.D., 35—11th Ave., Helena. Meets annually.

Nebraska

NEBRASKA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Ronald E. Waggener, M.D., Nebraska Methodist Hospital, Omaha. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England

CONNECTICUT VALLEY RADIOLOGIC SOCIETY. *Secretary-Treasurer*, Paul J. Kingston, M.D., 114 Woodland St., Hartford, Conn. Meets second Friday of October and April.

NEW ENGLAND ROENTGEN RAY SOCIETY. *Secretary*, John E. Gary, M.D., 1180 Beacon St., Brookline 46, Mass. Meets third Friday, October through May, Longwood Towers, Brookline, Mass.

New Hampshire

NEW HAMPSHIRE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Paul Y. Hasserjian, M.D., 1470 Elm St., Manchester. Meets three times a year.

New Jersey

RADIOLOGICAL SOCIETY OF NEW JERSEY. *Secretary*, Austin J. Tidaback, M.D., 912 Prospect Ave., Plainfield. Annual meeting in Spring, Atlantic City; Fall meeting October or November, Newark.

New York

BROOKLYN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, George A. Manfredonia, M.D., One Hanson Place, Brooklyn. Meets first Thursday of each month.

BUFFALO RADIOLOGICAL SOCIETY. *Secretary*, Alfred H. Dobrak, M.D., Sisters of Charity Hospital, Buffalo 14. Meets second Monday, October to May.

CENTRAL NEW YORK RADIOLOGICAL SOCIETY. *Secretary*, Joseph A. Head, M.D., University Hospital, 150 Marshall St., Syracuse. Meets first Monday, October through May.

KINGS COUNTY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, C. P. Naidorf, M.D., 411 Parkside Ave., Brooklyn 26. Meets fourth Thursday, October to April (except December), at 9:00 P.M., Kings County Medical Bldg.

NASSAU RADIOLOGICAL SOCIETY. *Secretary*, Jerome Zwanger, M.D., 126 Hicksville Road, Massapequa. Meets second Tuesday, February, April, June, October, and December.

NEW YORK ROENTGEN SOCIETY. *Secretary*, William B. Seaman, M.D., 622 W. 168th St., New York 32, N. Y.

NORTHEASTERN NEW YORK RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Irving Van Woert, Jr., M.D., Albany Hospital, Albany. Meets in the capital area second Wednesday, October, November, March, and April; annual meeting, May or June.

RADIOLOGICAL SOCIETY OF STATE OF NEW YORK. *Secretary-Treasurer*, Mario C. Gian, M.D., 610 Niagara St., Buffalo 1. Meets annually with the State Medical Society.

ROCHESTER ROENTGEN-RAY SOCIETY. *Secretary-Treasurer*, Theodore F. VanZandt, M.D., 501 W. Main St., Rochester 8. Meets last Monday of each month, September through May.

WESTCHESTER RADIOLOGICAL SOCIETY. *Secretary*, James C. Monteith, M.D., 170 Maple Ave., White Plains. Meets third Tuesday of January and October and as announced.

North Carolina

RADIOLOGICAL SOCIETY OF NORTH CAROLINA. *Secretary-Treasurer*, Owen Doyle, M.D., 1015 Professional Village, Greensboro. Meets in spring and fall of each year.

North Dakota

NORTH DAKOTA RADIOLOGICAL SOCIETY. *Secretary*, Richard F. Raasch, M.D., P.O. Box 990, Dickinson. Meets in the Spring with State Medical Association; in Fall or Winter on call.

Ohio

OHIO STATE RADIOLOGICAL SOCIETY. *Secretary*, Paul D. Meyer, M.D., 125 S. Grant Ave., Columbus. Society convention, Toledo, May 20–22, 1960.

CENTRAL OHIO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, William B. Schwartz, M.D., 1500 W. Third Ave., Columbus 12. Meets second Thursday, October, November, January, March, and May, 6:30 P.M., Fort Hayes Hotel, Columbus.

CLEVELAND RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Norman E. Berman, M.D., 14404 S. Park Blvd., Shaker Heights 20. Meets at 7:00 P.M., fourth Monday, October, November, January, February, March, and April, at Tudor Arms Hotel.

GREATER CINCINNATI RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Stanley J. Lucas, M.D., Provident Bank Bldg., Cincinnati 2. Meets first Monday, September through May, at Cincinnati General Hospital.

MIAMI VALLEY RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, G. F. Johnson, M.D., 1030 Reibold Bldg., Dayton 2, Ohio. Meets monthly, second Thursday, Miami Valley Hospital, Dayton.

Oklahoma

OKLAHOMA STATE RADIOLOGICAL SOCIETY. *Secretary*, J. Murphree, M.D., 617 E. Brookfield, Ponca City.

Oregon

OREGON RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Barbara J. Radmore, M.D., 1162 Willamette St., Eugene. Meets monthly, second Wednesday,

October to June, at 8:00 P.M., University Club, Portland.

Pacific Northwest

PACIFIC NORTHWEST RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Arch Colbrunn, Jr., M.D., 164 W. Tanager St., Roseburg, Ore. Next annual meeting in Vancouver, B. C., in May 1960.

Pennsylvania

PENNSYLVANIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Walter P. Bitner, M.D., 234 State St., Harrisburg. Next annual meeting, May 14–15, 1960, Pocono Manor.

PHILADELPHIA ROENTGEN RAY SOCIETY. *Secretary*, Robert B. Funch, M.D., Germantown Hospital, Philadelphia 44. Meets first Thursday of each month at 5:00 P.M., from October to May, in Thompson Hall, College of Physicians.

PITTSBURGH ROENTGEN SOCIETY. *Secretary*, Charles N. Chasler, M.D., Elizabeth Steel Magee Hospital, Pittsburgh 13. Meets monthly, second Wednesday, October through June, Park Schenley Restaurant.

Rocky Mountain States

ROCKY MOUNTAIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, John H. Freed, M.D., 4200 E. Ninth Ave., Denver 20, Colo. Next annual meeting, Aug. 11–13, 1960, Denver Hilton Hotel, Denver.

South Carolina

SOUTH CAROLINA RADIOLOGICAL SOCIETY. *Secretary*, Wayne Reeser, M.D., 1600 Ninth Ave., Conway. Meets with State Medical Association in May.

South Dakota

RADIOLOGICAL SOCIETY OF SOUTH DAKOTA. *Secretary-Treasurer*, Donald J. Peik, M.D., 303 S. Minnesota Ave., Sioux Falls. Meets during annual meeting of State Medical Society.

The Southeast

Southern Radiological Conference. *Secretary-Treasurer*, Marshall Eskridge, M.D., 1252 Springhill Ave., Mobile, Ala.

The Southwest

SOUTHWESTERN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Gordon L. Black, M.D., 1501 Arizona Bldg., El Paso, Texas.

Tennessee

EAST TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, J. Marsh Frere, Jr., M.D., 205 Medical Arts Bldg., Knoxville. Meets in September and January, and prior to State Medical Association meeting.

MEMPHIS ROENTGEN SOCIETY. *Secretary-Treasurer*, Hollis H. Halford, M.D., Kennedy VA Hospital, Memphis 15. Meets monthly first Monday, John Gaston Hospital.

TENNESSEE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, James J. Range, M.D., P.O. Box 324, Johnson City. Meets annually with State Medical Association in April.

Texas

CENTRAL TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Glenn Addison Stokdyk, M.D., VA Center, Temple. Meets monthly, fourth Monday, at Kosel's Cafe, Temple.

DALLAS-FORT WORTH RADIOLOGICAL CLUB. *Secretary*, Albert H. Keene, M.D., 3707 Gaston Ave., Dallas. Meets monthly, third Monday, 6:30 P.M., at the Greater Fort Worth International Airport.

HOUSTON RADIOLOGICAL SOCIETY. *Secretary*, Edward Singleton, M.D., 6621 Fannin St., Houston 25. Meets last Monday of each month at the Doctors' Club.

SAN ANTONIO-MILITARY RADIOLOGICAL SOCIETY. *Secretary*, Hugo F. Elmendorf, Jr., M.D., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets at Fort Sam Houston Officers' Club, third Wednesday of each month, 6:30 P.M.

TEXAS RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, R. P. O'Bannon, M.D., 1216 Pennsylvania Ave., Fort Worth 4. Next meeting in Houston, Jan. 22–23, 1960.

Utah

UTAH STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Richard V. Card, M.D., St. Mark's Hospital, Salt Lake City 3. Meets third Wednesday, January, March, May, September, November.

Vermont

VERMONT RADIOLOGIC SOCIETY. *Secretary-Treasurer*, John R. Williams, 46 Nichols St., Rutland.

Virginia

VIRGINIA RADIOLOGICAL SOCIETY. *Secretary*, Frank A. Kearney, 2nd, M.D., 110 S. Curry St., Phoebus.

Washington

WASHINGTON STATE RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Wayne A. Chesledon, M.D., 306 Stimson Bldg., Seattle 1. Meets fourth Monday, September through April, at College Club, Seattle.

West Virginia

WEST VIRGINIA RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Karl J. Myers, M.D., Myers Clinic-Broaddus Hospital, Philippi. Meets with State Medical Society, and as arranged by Program Committee.

Wisconsin

MILWAUKEE ROENTGEN RAY SOCIETY. *Secretary-Treasurer*, Joseph F. Wepfer, M.D., 5000 W. Chambers St., Milwaukee 10. Meets fourth Monday, October through May, at the University Club.

SECTION ON RADIOLOGY, STATE MEDICAL SOCIETY OF WISCONSIN. *Secretary*, Abraham Melamed, M.D.,

425 E. Wisconsin Ave., Milwaukee 2. Meets in October with State Medical Society.

WISCONSIN RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, Howard G. Bayley, M.D., 124 Winn Terrace, Beaver Dam.

Puerto Rico

ASOCIACIÓN PUERTORRIQUEÑA DE RADIOLOGÍA. *Secretary-Treasurer*, Dr. R. B. Díaz Bonnet, Suite 504, Professional Bldg., Santurce, P.R.

CANADA

CANADIAN ASSOCIATION OF RADIOLOGISTS. *Honorary Secretary-Treasurer*, Robert G. Fraser, M.D.; *Associate Honorary Secretary-Treasurer*, Jean-Louis Leger, M.D. *Central Office*, 1555 Summerhill Ave., Montreal 25, Quebec. Meets in January and June.

LA SOCIÉTÉ CANADIENNE-FRANÇAISE D'ELECTRO-RADIOLOGIE MÉDICALES. *General Secretary*, Louis Ivan Vallée, M.D., Hôpital Saint-Luc, 1058 rue St-Denis, Montreal 18. Meets third Saturday of each month.

L'ASSOCIATION DES RADIOLOGISTS DE LA PROVINCE DE QUÉBEC. ASSOCIATION OF RADIOLOGISTS OF THE PROVINCE OF QUEBEC. *Secretary*, O. Raymond, M.D., 5400 Blvd. Gouin W., Montreal 9. Meets four times a year.

MONTREAL RADIOLOGICAL STUDY CLUB. *Secretary-Treasurer*, Fleming McConnell, M.D., 1650 Cedar Ave., Montreal, Que. Meets first Tuesday evening, October to April.

TORONTO RADIOLOGICAL SOCIETY. *Secretary-Treasurer*, L. R. Harnick, M.D., X-Ray Department, Toronto Western Hospital, 399 Bathurst St. Meets second Monday evening, September to May.

CUBA

SOCIEDAD CUBANA DE RADIOLOGÍA Y FISIOTERAPIA. *Secretary*, Dr. Miguel A. García Plasencia, Hospital Curie, 29 y F, Vedado, Havana. Meets monthly.

MEXICO

SOCIEDAD MEXICANA DE RADIOLOGÍA. *Headquarters*, Calle de Coahuila, Núm. 35, Mexico 7, D. F. *Secretary General*, Dr. Jorge Ceballos Labat. Meets first Monday of each month.

PANAMA

SOCIEDAD RADIOLÓGICA PANAMEÑA. *Secretary-Editor*, Luis Arrieta Sánchez, M.D., Apartado No. 86, Panama, R. de P.

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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Congenital Absence of the Odontoid Process of the Axis. Report of a Case. E. L. Gillman. J. Bone & Joint Surg. **41-A:** 345–348, March 1959. (4100 Long Beach Blvd., Long Beach 7, Calif.)

Congenital malformation of the dens epistrophei is quite rare, only 21 cases having been previously reported. The anomalies are of three types: total absence of the dens; partial absence; and failure of fusion of the tip or separate ossicle (os odontoideum).

While, as a rule, there is a certain amount of demonstrable instability at the atlanto-axial joint in such malformations, this is apparently compatible with a normal existence. The defective dens or its absence is usually an incidental finding in roentgenograms of the cervical spine.

Seven roentgenograms.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Non-Traumatic Atlanto-Occipital and Atlanto-Axial Dislocation: A Case Report. Eleby R. Washington. J. Bone & Joint Surg. **41-A:** 341–344, March 1959. (Hospital for Crippled Children, Out-Patient Department, Newark, N. J.)

Since Bell first reported subluxation of the atlas on the axis in 1830, following a cervical infection, there have been sporadic reports of this relationship of events. It has been assumed that the dislocation in these cases is secondary to an inflammatory process of the joint and its periarticular structures and that it may originate either from an ascending lymphangitis or from direct extension.

The case reported in this paper is unique in that there was an accompanying forward dislocation of the atlas on the occiput. The patient was an 11-year-old Negro girl who had recurrent sore throat for a four-month period, culminating in severe cervical pain, muscle spasm, and difficulty in turning the head. Roentgenograms of the cervical spine demonstrated the abnormal relationships at C-1 and C-2. The child was treated with antibiotics, cervical traction, and cervical braces. The relationship of the atlas to the occiput reverted to normal while the atlas remained dislocated on the axis. The patient gradually became asymptomatic and two years later held her head in normal position and had a satisfactory range of motion.

Eight roentgenograms.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Facial Kinetograph: A Description of a Method for the Study of New Treatments for Facial Paralysis. August L. Stemmer. Ann. Otol., Rhin. & Laryng. **68:** 208–221, March 1959. (Massachusetts Eye and Ear Infirmary, Boston, Mass.)

A universally acceptable method that permits scientifically accurate graphic representation of facial function over prolonged intervals of time is worthy of attention, as it is a basis for the therapeutic program in any type of facial paralysis. The method described here has the advantages of simplicity, ease of adaptation, and accessibility within the usual hospital facilities. By means of the facial kinetograph, early clinically recognizable changes in facial muscular movement can be demonstrated and recorded.

Small lead markers are affixed to the labial commissures and their movement is recorded when the patient smiles during the exposure of an x-ray film. By comparing the abnormal with the normal side, after correcting for "skew," one is able to arrive at a measure of function during any period of time.

The patient is seated in front of the x-ray cone with his head tilted forward at an angle of approximately 30°, so that the lead shot at the commissures will be readily differentiated from metal fillings in the teeth, which may lie in juxtaposition. He is then told to smile and to relax on the 1–2 count; 1, smile; 2, relax; allowing one second for the height of the smile and one second back to normal. Thus, a two-second exposure is practical and there is little bony movement to obscure interpretations. With dried film on an x-ray viewing box, lines are drawn to show the outermost extremes of movement on both sides.

To estimate the amount of skew, one selects a center point which can be readily used for reference, such as the contact point between the two lower central incisors, or the genial tubercle of the mandible, along with the right and left lingula mandibulari, or the condylar heads. A line is then drawn connecting these points on each side, forming a "V." If the "V" is in a central position, interpretation can be considered within the limit of error of the investigator's ability to measure approximately 0.25 to 0.5 mm. with mechanical drawing instruments. If the "V" is falling on its side, with elongation of one of its legs, one must consider that foreshortening exists and the error can be calculated.

Four roentgenograms; 1 photograph; 1 diagram; 2 tables.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

Facial Sinuses of Dental Origin. Alan Hamilton. Brit. J. Surg. **46:** 433–441, March 1959. (Cheltenham Hospital, Cheltenham, England)

Reports of discharging sinuses of the face and neck from a source of dental infection are few, though their occurrence cannot be considered a rarity. An established discharging sinus may have its origin in an acute abscess from death of dental pulp with discharge to the buccal sulcus, or it may be the result of slow death of the dental pulp with subacute or chronic infection, giving rise to quiet tracking of pus. In either case the pus will find its way to the surface by the path of least resistance. Most commonly this is through the mucoperiosteum to the cheek sulcus, producing the appearance of a gumboil. There may, however, be involvement of the fascial planes, affecting in particular the floor of the mouth, resulting in a submandibular abscess. If the source is not removed, then the sinus will persist and discharge constantly.

Nine cases of facial and submandibular sinuses from dental causes are presented (6 in detail), illustrating the diagnosis and treatment of the sinuses. The author states that roentgenograms may be misleading at times but are essential in making the diagnosis. Emphasis is laid on the necessity of multiple views taken from different angles. Intraoral films will show earlier and obscure changes more accurately.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Secretory Sialography in Diseases External to the Major Salivary Glands. Irving M. Blatt, John E. Magielski, James H. Maxwell, and John F. Holt. Ann. Otol., Rhin. & Laryng. **68:** 175–186, March 1959. (University Hospital, Ann Arbor, Mich.)

Secretory sialography has been a useful aid in determining whether tumors in the submaxillary and parotid regions are within or adjacent to the major salivary glands. This report is concerned with the results of a sialographic study of 31 patients in whom regional swellings external to the salivary glands were present.

Demonstration of any gross deviation from the normal duct pattern is best accomplished by introduction of the contrast material through a polyethylene catheter, by a closed system of injection. Extrinsic masses may cause displacement, compression, or distortion of the duct system, with preservation of the general architectural pattern. Each duct is seen in its entirety, although its shape and configuration will vary with the degree of displacement. Occasionally a circumscribed radiodensity, quite apart from the duct system, may appear as an intrinsic salivary gland lesion in certain radiographic projections. The sialogram, however, demonstrates its precise location, and identifies it as a probable phlebolith of the cheek. Such a lesion could easily be confused with a parotid calculus on routine roentgenography.

Secretory sialography is valuable in identifying lesions extrinsic to the major salivary glands, whether inflammatory or neoplastic, since complete emptying of the ducts and acini occurs immediately following stimulation. This serves to differentiate extrinsic and intrinsic salivary gland neoplasms, since the latter usually show retention of contrast material in post-evacuation films. A radiopaque medium of low viscosity, such as Pantopaque, is ideal since it is readily washed out of the duct system by the salivary secretion.

The findings in the authors' 31 cases are tabulated.

Sixteen roentgenograms; 1 table.

STEPHEN N. TAGER, M.D.
Evansville, Ind.

The Radiological Picture of the Thyroid. A. Torsoli, M. Mele, M. L. Ramorino, B. Fella, and C. Colagrande. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 438–445, October 1958. (In German) (Istituto di patologia medica dell'Università di Roma, Rome, Italy)

The authors report their experiences with retroperitoneal insufflation and anterior pneumothyrography in 38 patients. The thyroid is better visualized with anterior thyrography, because only the space between the thyroid capsule and the perithyroideal tissues is demonstrated. With retroperitoneal insufflation, other structures in the neck, such as muscles, etc., are shown; subcutaneous emphysema is also present. Neither method is dangerous.

From pneumothyrograms information as to the volume and the weight of the thyroid can be derived. Stratigrams are made in the anteroposterior, lateral, and axial projections. The gland is measured in different projections and from these measurements its size and weight are obtained.

The pneumothyrograms were compared with radiothyrograms to add functional data to the radiologic picture.

Ten roentgenograms; 3 drawings.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

THE CHEST

Minimal Active Tuberculosis: An Increasingly Difficult Diagnosis. J. A. C. Gray and G. E. Spencer. Dis. of Chest **35:** 266–272, March 1959. (U. S. Naval Hospital, St. Albans, N. Y.)

The authors attribute the growing difficulty of diagnosing minimal active tuberculosis, to absence of symptoms and the prevalence of the fungous diseases. During a three-year period (Oct. 1, 1953 to Sept. 30, 1956), at the U. S. Naval Hospital, St. Albans, N. Y., a diagnosis of minimal active tuberculosis was made in 166 members of the U. S. Navy and Marine Corps. During the same interval, the diagnosis of moderately advanced tuberculosis was established in 227 and far advanced tuberculosis in 100. Histoplasmosis was diagnosed in 28 cases and coccidioidomycosis in 4.

Of the 166 patients with minimal tuberculosis, 2 were females and 164 males, approximately two-thirds being under twenty-five years of age; 156 were Caucasians, 9 Negroid, and 1 Malayan. Twenty-nine (17.5 per cent) had symptoms referable to tuberculosis; in 128 there were no symptoms and the disease was found on routine x-ray examination of the chest. Nine patients were hospitalized for other ailments and the pulmonary lesions were recognized on a routine x-ray examination of the chest.

The x-ray findings were described as exudation 96 times, nodulation 30, exudation plus nodulation 24, fibrosis and/or calcification 28, and coin lesions 4. The process was generally located in the apical and posterior segmental areas of the upper lobes. Tracheobronchial and hilar lymphadenopathy was reported once.

All of the 166 patients reacted to tuberculin. Previous reactivity was known in 85; 69 (81.2 per cent) were "Mantoux-negative," and the other 16 (18.8 per cent) were "Mantoux-positive." This would indicate that most of the infections were of recent origin and occurred in early adult life.

Seventy-two of the cases were found to be bacteriologically positive by ordinary methods. *Mycobacterium tuberculosis* was identified by culture in all but 2 cases with positive sputum smear. In 22 cases in which excisional surgery was done, examination of the excised tissue yielded bacteriological proof of tuberculosis in only 9.

Summarizing the diagnostic aspects, the authors found but 118 cases (71.1 per cent) proved bacteriologically or by conversion of the Mantoux reaction. In 48 only a clinical diagnosis was possible. The comment is made that "case finding by means of roentgenographic examination of the chest has far outstripped the ability of the microbiologist," and "the clinician is often unhappily forced to make momentous decisions about his patients on the basis of incomplete evidence."

Four tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Chest X-Rays: Analysis of Data from Reading and Re-Reading Films. William Seeman. J. Kansas M. Soc. **60:** 135–136, March 1959. (University of Kansas Medical Center, Kansas City 12, Kans.)

Data from the controlled interpretations of 89 chest radiographs originally reported by Garland and Cochran (J.A.M.A. **149:** 631, 1952. Abst. in Radiology **60:** 611, 1953) are re-analyzed statistically in an attempt to clarify some aspects of the study from a purely statisti-

cal basis. The article would be of interest only to those concerned with the derivation and significance of mathematical statistical analyses. No clinical points are made.

Two tables. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Coexisting Primary Lung Carcinoma and Pulmonary Tuberculosis. A Report of Fifteen Cases Discovered Through a Chest Clinic and Hospital. F. Clark White, Frederick Beck, and David V. Pecora. Am. Rev. Tuberc. **79:** 134–142, February 1959. (Ray Brook State Tuberculosis Hospital, Ray Brook, N. Y.)

A retrospective analysis of experience with patients having pulmonary tuberculosis and primary lung carcinoma was undertaken. Fifteen cases are reported with this combination of diseases. The neoplasm was found to develop in an area previously involved by tuberculosis in 6 patients and arose in an area apparently uninvolved by tuberculosis in 7 patients. The primary site was not determined in 1 patient with alveolar-cell carcinoma, and the other patient had a negative tuberculin reaction at the time of the diagnosis of carcinoma, with later development of tuberculosis.

The roentgen picture was that of tuberculosis with additional findings which could be recognized as due to neoplasm in 13 patients. In 7 of these the earliest evidence of carcinoma was a circumscribed pulmonary parenchymal nodule in the mid lung zone. The presenting roentgenographic sign in 3 patients was unilateral hilar enlargement, and in 2 of these partial atelectasis of a segment was present. Partial atelectasis was the presenting sign in 2 instances, and in 1 spontaneous pneumothorax developed and tuberculosis as well as carcinoma was found in the lung after re-expansion. The carcinoma could not be recognized roentgenographically even in retrospect in 2 patients. In most cases the shadows caused by carcinoma increased rapidly over a period of several months and were unrelated to the roentgenographic course of the tuberculosis. This dissimilar roentgenographic behavior of lesions in different parts of the lung was the major clue suggesting the presence of neoplasm.

Pulmonary tuberculosis was the initial disease process in 10 of the patients, and the evidence of tuberculosis had been present for a period of more than four years in 9 of these. The diseases were recognized simultaneously in 4 patients and in 1 the carcinoma preceded the tuberculosis. Examination of the previous films following the diagnosis of carcinoma showed evidence of the neoplasm two to three years before recognition in 2 patients, one year in 2 patients and between eight months and one week in 9 patients. The diagnosis was made postmortem in the remaining 2.

The authors conclude that the development of a nodular density which is homogeneous rather than mottled and occurs in the mid lung zone rather than in the periphery, which increases in size in a manner often unrelated to the clinical course of the tuberculosis, should suggest neoplasm. Unilateral hilar enlargement and partial atelectasis of a segment or lobe are also findings suggesting neoplasm in patients with tuberculosis. Once the diagnosis is suspected, the usual diagnostic methods, including bronchoscopy, examination of bronchial washings for neoplastic cells, scalene node biopsy, etc., should be employed.

Eight roentgenograms. JOHN H. JUHL, M.D.
University of Wisconsin

Pulmonary Cystic Disease: Observations in Cases Treated by Exploratory Thoracotomy. Mark H. Joress. Dis. of Chest **35:** 256–265, March 1959. (Outpatient Clinic, Veterans Administration, Boston 8, Mass.)

The author analyzes 21 cases of localized cystic disease of the lungs confirmed by thoracotomy. Symptoms were constantly present in 11 and intermittently in 8, while 2 were asymptomatic, being diagnosed on routine x-ray examination. The symptoms encountered were cough, sputum, chest pain, dyspnea, hemoptysis, spontaneous pneumothorax, fever, weight loss, chest colds, wheezing, and difficulty in swallowing. Symptoms depend upon lung compression, infection, rupture of vessels, and rupture of a cyst, resulting in a pneumothorax.

Roentgenographic findings vary. Small cysts may not be recognized. In general, there are ill defined areas of increased aeration or radiolucency, with decreased vascular markings, or none at all. Sometimes a thin wall is discernible. If the cyst is large, the adjacent lung is compressed and may resemble an area of localized fibrosis. Trabeculations may be present in the cyst. When rupture occurs, a pneumothorax is evident. The cystic disease may be masked by other lesions, with recognition of its true nature only at the time of surgery. A cyst with retention of secretions, depending upon location, may resemble an enlarged hilar or mediastinal lymph node, a pulmonary or mediastinal neoplasm, or a diaphragmatic hernia. If very large, it may be confused with an empyema. When a lung cyst becomes infected, it can simulate a lung abscess, bronchiectasis, tuberculosis, or pneumonitis. In one instance there was resemblance to an arteriovenous fistula.

In this series, the x-ray findings in 9 cases were consistent with cystic disease; in the other 12 they were not.

Nine roentgenograms; 3 tables.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Gestational Pulmonary Choriocarcinoma Apparently Primary. G. Brouet, J. Chrétien, J. Marche, and G. Roussel. J. franç. de méd. et chir. thorac. **13:** 211–222, 1959. (In French) (Paris, France)

A 39-year-old woman gave a history of three pregnancies at twenty-six, thirty-four, and thirty-eight years of age. The first was normal but the other two were followed by irregular bleeding, which necessitated hormonal therapy. The chief complaint upon admission was hemoptysis. A roentgenogram of the chest revealed a nodule measuring 3 by 4 cm., in the lingula. There was an increase of gonadotropin B in the serum, as well as an increase in urinary phenol-steroids. Hysterography revealed nothing abnormal in the uterus. Curettage and tissue study showed some degree of hyperplasia of the endometrium.

Hysterectomy disclosed only inflammatory changes in the uterine mucosa with no evidence of tumor. There was a definite drop in the level of gonadotropins after surgery. By this time the pulmonary nodule had grown to 7 by 8 cm. and a lobectomy was performed, leading to a microscopic diagnosis of choriocarcinoma. There was a further drop in the level of Prolan B after this operation.

The patient was apparently well following the second operation. Three months later she died of cerebral metastasis.

It is difficult to state whether this tumor was primary

in the uterus and underwent an involution to almost microscopic size or whether it was actually an ectopic choriocarcinoma, primary in the lung. It still seems possible that the patient may have had a very small tumor in the uterus which metastasized. The interest of the case lies in the fact that the pulmonary lesion appears to have been the principal cause of symptoms.

Four roentgenograms; 2 photomicrographs; 1 photograph.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Pulmonary Choriocarcinoma Arising from Late Degeneration of Emboli of Molar Cells. P. Galy, M. Latarjet, and R. G. Touraine. J. franç. de méd. et chir. thorac. **13:** 201–203, 1959. (In French) (Lyons, France)

A case of pulmonary choriocarcinoma thought to arise from late degeneration of emboli of molar cells is reported.

Signs of right pulmonary congestion with cough and expectoration were observed in a 31-year-old woman who complained of hemoptysis during menstruation. Roentgen examination demonstrated a well circumscribed round nodule in the lung, about the size of an orange. The lesion was excised and histologically proved to be a choriocarcinoma. Hysterography at this time did not reveal a tumor.

Five years earlier a benign hydatidiform mole had been removed by curettage during the fifth month of pregnancy. The curettage had been followed ten months later by spontaneous miscarriage of a one and one-half month old fetus. There had been normal pregnancies nine and eight years prior to admission.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Pulmonary Choriocarcinoma Discovered Three Years After Molar Abortion: Atypical Resection Following Hysterectomy; Apparent Cure with a Recession of Two Years. J. Chrétien, O. Monod, and R. de Ruyck. J. franç. de méd. et chir. thorac. **13:** 223–233, 1959. (In French) (Paris, France)

A 26-year-old woman who was seen because of asthenia and loss of weight over the past five months was found to have a nodule, 2 × 1 cm., in the right upper lung field. Three years earlier she had spontaneously passed a hydatidiform mole, with reversion of hormonal changes to normal thereafter. Eight months before admission she had given birth to a normal child.

It was at first believed that the patient had tuberculosis and therapy was accordingly instituted. Approximately four months later, however, the nodule had increased in size to 3 × 3 cm. On, removal histopathologic study revealed choriocarcinoma. Later, hormonal studies were done, following which the uterus was removed. Again hormonal studies were performed. The prolan levels were normal in each instance.

The pathogenesis of this lesion is briefly discussed. One possibility considered is that it was a primary ectopic choriocarcinoma; another that a small focus of tumor cells may have metastasized to the lungs, later entering a period of growth and becoming malignant.

Seven roentgenograms; 1 photomicrograph; 1 photograph.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Pulmonary Choriocarcinoma After Pregnancy; Survival for Six and One-Half Years After Exeresis. J. Varangot, A. Granjon, and S. Yannotti. J. franç. de méd. et. chir. thorac. **13:** 205–209, 1959. (In French) (Paris, France)

The authors report the case of a 31-year-old woman who had a normal delivery eight years and a molar abortion seven years before admission. A third pregnancy, two years before admission, had terminated normally. A few months later, uterine bleeding developed. Gynecologic examination showed a cervical ulceration and a moderate secondary anemia, but no definite evidence of tumor. Two well circumscribed nodular lesions were noted in the right lung.

Hysterectomy was performed, followed later by a right middle lobe lobectomy and segmental resection of part of the right lower lobe. None of the pelvic tissues showed any evidence of chorioepithelioma. The level of gonadotropins in the urine decreased to normal after the removal of the pulmonary tissue. The tumor was thought to be chorioepithelioma.

The patient was seen six and one-half years later and appeared well.

Two roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Late Pulmonary and Cerebral Metastases from a Chorioepithelioma Treated by Total Hysterectomy Eight Years Previously. Ch. Gernez-Rieux, C. Voisin, and P. Fournier. J. franç. de méd. et chir. thorac. **13:** 235–237, 1959. (In French) (Hôpital Calmette, Lille, France)

A 25-year-old woman had a total hysterectomy after a diagnosis of chorioepithelioma was made. Eight years later, when she was seen because of a chronic cough and weight loss, a large nodular density with small cavities was found to occupy most of the right lower lobe of the lungs. Cerebral symptoms developed shortly thereafter, and electroencephalography and arteriography suggested a tumor metastasis. Pathologic study of the pulmonary tumor revealed choriocarcinoma.

Two roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Idiopathic Pulmonary Atrophy (Vanishing Lung and Unilateral Emphysema). Piero Fornara. Arch. Pediat. **76:** 53–63, February 1959. (Ospedale Maggiore, Novara, Italy)

The pathogenesis and history of a syndrome known as "vanishing lung," "lobar emphysema," and "abnormal transradiancy of the lung," are discussed.

The author reports the case of a boy who had pneumonia when one year old. At the age of six, he was seen with febrile bronchopneumonia of the right pulmonary base. Roentgen studies at that time revealed an infiltration of the lower half of the right lung and a hypertransparent view of the upper half of the left hemithorax, with emptiness of the hilar horn, especially evident on tomography. Bronchography showed that the left upper bronchial tree was thin, with a downward displacement of the upper lobar bronchus which became more visible and showed an approximation of the lower branches of the same side.

After recovering from the right bronchopneumonia, the child had no more respiratory troubles. Chest roentgenograms taken one month and seven months

after the acute episode showed persistence of the hypertransparency of the upper part of the left hemithorax.

Eight roentgenograms.

Mucormycosis of the Lung. A Case Without Significant Predisposing Factor. Herman W. Blankenberg and Dirk Verhoeff. Am. Rev. Tuberc. **79:** 357–361, March 1959. (Mecklenburg Sanatorium, Huntersville, N. C.)

Mucormycosis usually occurs in debilitated patients, often in uncontrolled diabetics, and is usually fatal in this circumstance. The authors present the case of a 23-year-old Negress who gave a history of a non-productive cough three months prior to admission. This was followed in two months by what was thought to be a chest cold. Ten days prior to admission the patient began to produce an ounce of blood-streaked sputum daily and to run a fever. The chest roentgenogram showed the presence of a large pulmonary abscess or cyst in the right lower lobe, with multiple fluid levels and dense consolidation of the adjacent lung. Several nodules were noted in the left lung field, the largest measuring 2 cm. in diameter. The patient did not respond to antibiotics, and nine days after admission the right middle and lower lobes were resected surgically. Large poorly defined cavities were found in both lobes. They were surrounded by thick layers of hemorrhagic and necrotic tissue. Microscopic examination revealed the presence of the fungus *Phycomycetes rhizopus*. A marked tendency to invade vessels was noted. Following surgery, the nodules in the left lung regressed, and observation one year after surgery revealed no residual disease. Fourteen months after surgery, however, diabetes was discovered.

Two roentgenograms; 1 photomicrograph; 1 photograph.

JOHN H. JUHL, M.D.
University of Wisconsin

Bronchopulmonary Geotrichosis: A Review with Report of Four Cases. B. H. Webster. Dis. of Chest **35:** 273–281, March 1959. (706 Church St., Nashville 3, Tenn.)

Many saprophytic fungi may become pathogenic to man. *Geotrichum* is such a fungus, and may result in an acute, subacute, or chronic infection of the mouth, bronchi, lungs, or gastrointestinal tract. A superimposed infection with *Geotrichum* may aggravate a preexisting pulmonary condition.

Geotrichosis is rare, but the author is able to describe the findings in 4 pulmonary cases. In one, tuberculosis subsequently developed. This resolved, but the geotrichosis persisted for another two years. In the second, there was a simultaneous Friedländer bacillus and *Geotrichum* infection, with the production of pneumonia. In the third, geotrichosis was superimposed upon an emphysema. The fourth case showed a patchy infiltration with cavitation.

The roentgenographic observations in the chest are not specific. In the bronchial variety of the disease there is a diffuse peribronchial infiltration which may extend as fine strands into the periphery or the bases. The pulmonary form shows dense areas of infiltration, usually in the upper lobes. Cavitation may be present. The x-ray findings are indistinguishable from pulmonary tuberculosis.

Five figures, including 3 roentgenograms.

HENRY K. TAYLOR, M.D.
New York, N. Y.

Chronic Pulmonary Schistosomiasis. Z. Farid, J. W. Greer, K. G. Ishak, A. M. el Nagah, P. C. LeGolvan, and A. H. Mousa. Am. Rev. Tuberc. **79:** 119–133, February 1959. (U. S. Naval Medical Research Unit No. 3, Cairo, Egypt)

Pulmonary schistosomiasis has been reported from Egypt and other parts of Africa, Jerusalem, and Iraq in the Middle East, from Venezuela and Brazil in South America, and from Puerto Rico. The *Schistosoma* ova reach the pulmonary circulation from the veins of the bladder and intestine and as emboli obstruct the pulmonary arterioles. The egg then makes its way through the intima, media, and adventitia, coming to lie outside the arteriolar wall, where it produces a tissue reaction, ultimately resulting in a granuloma. The vascular lesions are due to the passage of the ova through the vessel walls, producing inflammation and necrosis. As this heals, the resultant fibrosis causes partial or complete occlusion of the arteriole. When these vascular lesions are widespread, a diffuse obliterating endarteritis occurs, which restricts the capacity of the pulmonary vascular bed and leads to an increase in pulmonary pressure. As a consequence, the pulmonary artery dilates and may reach a very large size.

The roentgenographic appearance of advanced pulmonary schistosomiasis is characteristic. The pulmonary artery and its main branches are markedly dilated in contrast to rather small or average sized mid and peripheral zone vessels. Fluoroscopically the dilated right pulmonary artery has a characteristic pulsatile downward thrust. Occasionally a fine mottling of the pulmonary parenchyma is demonstrated. The right ventricular outflow tract is distended and eventually the right ventricle becomes enlarged.

Fifteen cases are reported in this paper. Right heart catheterization demonstrated elevated pulmonary arterial pressure on all 13 of the patients who were examined. Pulmonary function studies demonstrated mild ventilatory insufficiency with very little diffusion defect.

Six roentgenograms; 7 photomicrographs; 1 photograph; 1 electrocardiogram; 2 charts; 7 tables.

JOHN H. JUHL, M.D.
University of Wisconsin

The Roentgen Findings in So-Called "Asiatic Flu." M. S. Del Buono. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 171–178, February 1959. (In German) (Universität Zürich, Zürich, Switzerland)

The "Asiatic flu" epidemic of the winter of 1957–58 produced roentgen findings similar to those observed in the "grippe" epidemic of 1918. If a pneumonia occurred, it was either caused by the influenza virus A or was due to a secondary bacterial infection, usually by a hemolytic *Staphylococcus aureus*. The author studied 31 proved cases from the recent epidemic. Four types of pneumonia are listed but there are many mixed forms.

1. Massive *confluent bronchopneumonia* is the most dangerous form. Of 14 patients with this form of the disease in the author's series, 8 died. The infiltrations often involve both lungs and are never homogeneous. Their outlines are indistinct, blurred, and irregular.

2. In *central pneumonia*, the infiltrations originate from the hilus; on the left they occur chiefly in the lingula, and on the right in the medial portion of the middle lobe. The hilus cannot be clearly separated from the infiltrations. This type of involvement was present in 14 of the author's cases.

3. Four cases of *miliary bronchopneumonia* were

observed, showing small infiltrations scattered over a whole segment of the lung or over both lungs.

4. Homogeneous, *pseudolobar pneumonia*, involving one segment or one lobe, was seen in 10 patients, including 2 with Group 1 and 4 with Group 2 disease.

Complications consisted of effusions, abscesses, pneumothorax, and atelectases.

The more serious cases and those that terminated fatally were all caused by a superimposed *Staphylococcus* infection. The virus pneumonia without secondary infection was characterized by perihilar infiltrations resembling frosted glass and by a mild clinical course, with complete restitution.

Six roentgenograms; 1 table.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Massive Pulmonary Opacities in Iron Miners. P. Lamy, R. Senault, P. Sadoul, R. Huttin, and J. Guillerm. J. franç. de méd. et chir. thorac. **13:** 283–292, 1959. (In French) (Nancy, France)

Iron miners who spend from fifteen to twenty-five years in an environment containing considerable iron dust may show massive opacities in the lung. Silicotic masses are composed of fibro-hyaline tissue with few cells, perhaps containing some particles of dust, irregularly disposed. Siderotic masses consist of accumulations of iron oxide. Chemical analysis reveals relatively little silica in the pneumoconiosis of iron miners.

This paper is based on 45 original observations, the majority occurring in miners who had been working in the iron mines for over twenty years. The radiologic picture is usually that of a large opacity with relatively well demarcated borders, occurring in the upper lung fields. Sometimes there are several smaller masses. A few small calcifications may be present. Other cases may show variations of the pattern and relatively little tendency to formation of a well demarcated mass. Emphysematous blebs or bullae may occur in the regions peripheral to the mass.

A word of caution is given, namely that carcinoma of the lung may occasionally arise as a coincidental finding and should be considered if any unusual mass or atelectasis of a considerable degree is present.

Eleven roentgenograms.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Hazards with Local Anaesthetics During Bronchography and Bronchoscopy. Samir Kumar Gupta. Brit. M. J. **1:** 695–696, March 14, 1959. (Islington Chest Clinic, London, England)

Severe reactions were observed in 5 patients after anesthetization preparatory to bronchoscopy or bronchography. The agents used were amethocaine hydrochloride, which belongs to the procaine group, and lignocaine, a drug chemically allied to acetanilide. In one case the patient had at least four times the safe dosage of amethocaine; moreover, it was administered through a nasal catheter, a dangerous method. Toxicity was definitely present in this instance and probably in another case as well. Hypersensitivity was certainly the cause of the reaction in one case and probably so in another. In one case it was difficult to determine the offending drug.

No history regarding previous sensitization to local analgesics was available in any instance.

Obstruction of Respiratory Tract in the Flexed Foetus; A Preliminary Communication. Angus Smith. Brit. M. J. **1:** 344–345, Feb. 7, 1959. (Charing Cross Hospital, London, England)

Radiological investigation of the tracheobronchial tree was undertaken in 10 stillborn infants who had died a few hours before birth. An endotracheal catheter was placed just through the vocal cords of the seated baby flexed in the intrauterine position. Lipiodol was injected until it began to run back from the mouth. A roentgenogram at this stage showed the contrast agent to be held up just beyond the tracheal bifurcation, and the appearance was that of a kinked tube. When the child's body was straightened, the Lipiodol ran on freely and an effective bronchogram was obtained.

It would seem that in the flexed fetus with unexpanded lungs there is a definite obstruction of the main bronchi, which appear radiologically to be kinked. This may be the reason fetal lungs are not fully expanded by liquor amnii *in utero*, where respiratory effort undoubtedly occurs.

Three roentgenograms.

Giant Lymph Node Hyperplasia of the Mediastinum. Case Report with a Review of the Literature. Kiyoshi Inada, Keizo Kawai, Tatsuki Katsumura, and Akinori Nakano. Am. Rev. Tuberc. **79:** 232–237, February 1959. (Okayama University Medical School, Okayama, Japan)

The authors report massive anterior mediastinal adenopathy in a patient who complained of fever, cough, back pain, and general fatigue developing one month prior to hospital admission. Roentgen examination revealed a large, somewhat lobular mediastinal mass extending to obscure the left lung apex and much of the left upper lung field, as well as the left hilus and the upper half of the cardiac silhouette. It also extended about 2 cm. to the right of the trachea, which was deviated to the right and downward to obscure the right hilus. In the lateral projection the mass was noted to lie anteriorly. It was surgically removed and found to measure 16 × 9 × 5.5 cm. and to weigh 390 gm. It was well encapsulated but was lobulated in some areas. Microscopic sections revealed reactive lymphoid hyperplasia, resembling a thymoma.

Lymph nodes do not ordinarily attain the size of the one reported here, but a few reaching comparable size were found in the American and Japanese literature by the authors. Castleman has seen about 25 cases belonging to this category.

Two roentgenograms; 4 photomicrographs; 1 photograph; 1 table.

JOHN H. JUHL, M.D.
University of Wisconsin

Attempts at Standardization of Tracheal Function Tests. H. Zimmermann. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 425–438, October 1958. (In German) (Universität München, Munich, Germany)

The Valsalva and Müller maneuvers give valuable information concerning the shape, position, and size of goiters as well as the degree of tracheomalacia. The author supplements roentgen examination with the use of an instrument based on the manometer and is thus able to record pressure changes more accurately than can be done with roentgenography alone.

Several examples are cited to demonstrate the diagnostic possibility of this method.

Twenty-five roentgenograms; 1 photograph; 5 drawings.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

THE HEART AND BLOOD VESSELS

Simultaneous Aortography and Arteriography. S. Masy, G. Toussaint, and Charles Chalant. J. belge de radiol. **42:** 166–176, 1959. (In French) (Cliniques Universitaire Saint-Pierre, Louvain, Belgium)

The authors describe their method for simultaneous aortography and arteriography. While Seldinger's catheterization technic is preferred when visualization of the kidneys is desired, direct aortic puncture is the procedure of choice for the study of arterial disease, because of the possibility that a thrombus may be dislodged during insertion of a catheter. Before exposure of the films, 4 ml. of contrast agent is injected to make sure that the needle is in the correct position.

Serial films are to be desired, especially to distinguish between obstruction and slow filling of vessels. The authors had a hexagonal drum made which they place under the radiographic table. On each of its walls is a cassette which measures 35 × 105 cm. The roentgenograms are taken at 1.5 second intervals.

The tube is placed 1.5 meters from the film, centered on the pubis, and then inclined 20° toward the feet, so that the field covered extends from the third lumbar vertebra to the ankles. A fixed grid is used under the pelvis and thighs. Each cassette contains a pair of rapid screens under the pelvis, a pair of normal screens under the thighs, and a single screen under the legs.

Nearly 300 arteriographic examinations have been carried out with this method with no unusual complication except some degree of vascular spasm. This may be controlled by injection of a small amount of 1 per cent Novocain following introduction of the contrast agent.

Six case reports, a photograph of the apparatus, and seven roentgenograms are included.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Retrograde Aortography Under Controlled Hypotension. F. Pinet, J. Gravier, and A. Pinet. J. de radiol. **40:** 115–126, March–April 1959. (In French) (Clinique chirurgicale du Pr Santy, Lyons, France)

The authors use camphosulfonate of trimetaphane to produce arterial hypotension as an aid to retrograde aortography. Apparently the proprietary name of the drug is Arfonad. Its action is short, the effects completely disappearing within ten or fifteen minutes. It is administered from an ampule which contains 250 mg. which has been dissolved in 250 ml. of saline or isotonic glucose. This is allowed to flow into the veins until the blood pressure starts to drop.

In the opinion of the authors the induction of hypotension is of advantage for demonstration of the aorta and its various branches. The internal mammary arteries are well shown on some of the reproductions and small arteries such as the coronaries are also relatively well shown.

Sixteen roentgenograms; 1 chart.

CHARLES M. NICE, JR., M.D., Ph.D.
Tulane University

Retrograde Levocardiography in Connection with Measuring of Intracardial Pressure. W. Porstmann, W. Geissler, and W. Wolf. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 397–409, October 1958. (In German) (Institut für Röntgenologie der Charité, Berlin, Germany)

The authors' method of left retrograde cardiography calls for exposure of the right common carotid and passage of a catheter *via* the aorta. A semi-flexible catheter is inserted under fluoroscopic control, preferably with amplification. Simultaneously, an electrocardiogram is obtained and pressure determinations are made. Up to 60 c.c. of contrast medium is injected (1.0 c.c. per kilogram of weight) in one to two seconds. In children, general anesthesia is used. Usually, extrasystoles occur when the catheter passes the aortic valve and also during the injection of the contrast substance.

The method demonstrates the outflow tract of the left ventricle and the aortic valve and may reveal mitral valve insufficiency or septal defects. At the same time, pressure curves characteristic of various aortic valve lesions are obtained.

In the authors' series of 17 cases, 6 valvular and 2 subvalvular stenoses were discovered in patients aged from two to forty-three years. Seven cases are illustrated. In one patient, with mitral disease, hemiparesis developed, which regressed slowly.

Nineteen roentgenograms; 4 curves.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

Puncture of the Left Ventricle for Contrast Demonstration of the Outflow Tract. F. Grosse-Brockhoff, H. H. Löhr, F. Loogen, and H. Vieten. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 300–308, March 1959. (In German) (Medizinische Akademie, Düsseldorf, Germany)

In order to demonstrate the outflow tract, the authors, in a two-year period, have performed percutaneous puncture of the left ventricle for the introduction of contrast medium in 26 patients. Intratracheal anesthesia is used, blood pressure is measured directly either in the femoral or brachial artery, and a continuous electrocardiogram is made.

The technic of injection is described in detail. After the needle is inserted in the left ventricle and ventricular pressure is determined, the contrast material is injected, and serial films are obtained at the rate of 3 per second, simultaneously in two projections.

The procedure is not without danger, due to possible ventricular fibrillation, extrasystoles, auriculoventricular block, air embolism, and heart tamponade. The chief indications for its use are in evaluation of aortic stenosis, aortic arch syndrome, and in questionable ventricular septal defects. It should be limited to cases where the angiogram is not sufficient for differential diagnosis.

Seven roentgenograms; 4 charts.

ILONA D. SCOTT, M.D.
Lewisburg, W. Va.

An Improved Method of Venography. George C. Godfrey, Joseph M. Miller, and Milton Ginsberg. Surg., Gynec. & Obst. **108:** 375–378, March 1959. (VA Hospital, Fort Howard, Md.)

Venography at a leisurely pace is made possible by a continuous infusion of dilute contrast medium.

A solution of 14 per cent Urokon is made by mixing 50 ml. of a 70 per cent solution of Urokon with 200 ml. of physiological saline in a bottle designed for intravenous administration of fluids. With the patient in

the supine position, a venipuncture is performed as distally as possible on the lower part of the leg or foot. The solution is administered under increased pressure controlled by injecting air into the bottle. When 100 c.c. has entered the vein, the flow is reduced and roentgenograms of the leg are made in the supine and lateral positions. A final roentgenogram of the abdomen is made in the supine position for visualization of the pelvic veins.

Care must be taken that the infusion is discontinued before air is inadvertently introduced into the veins from the pressurized bottle.

The authors have applied this method of venography to a series of 25 patients without encountering a local reaction. The anterior tibial, posterior tibial, popliteal, and superficial femoral veins were consistently demonstrated. As a consequence of the continuous infusion of the contrast medium, adequate roentgenograms were obtained without the necessity of exposing medical personnel to radiation.

Ten roentgenograms.

DAVID E. KUHL, M.D.
University of Pennsylvania

Renal Function After Selective Renal Angiography. An Experimental Study in Dogs. N. P. G. Edling, C. G. Helander, F. Persson, and Å. Åsheim. Acta radiol. **51:** 161–169, March 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

The response of renal tissue to contrast medium injected directly into the renal artery was studied in 24 healthy dogs. In some animals renal function was studied before and after injection of the medium. Microscopic study of the kidneys was done twenty-five to thirty-three days after injections.

It was found that an abnormal angiographic effect was always associated with severe renal damage; on the other hand, with absence of renal failure angiographic appearances were normal. Occasionally a normal angionephrographic study was associated with slight or (rarely) severe renal injury.

Renal injury usually follows injection of large doses of contrast material, but there is no invariable correlation between the degree of severity of the damage and the dose and concentration of the medium. Ischemia of the renal tissue seems to be of importance. The study suggests that the risks of renal damage are greater in selective renal angiography than in renal aortography.

Two photomicrographs; 1 table.

GEORGE L. SACKETT, M.D.
Cleveland, Ohio.

An Evaluation of Newer Opacification Media: Diatrizoate and Diprotrizoate. Theodore B. Massell, E. Craig Heringman, and S. M. Greenstone. Arch. Surg. **78:** 293–299, February 1959. (6221 Wilshire Blvd., Los Angeles, Calif.)

A comparative evaluation was made of Miokon Sodium (sodium salt of diprotrizoate), Hypaque Sodium (sodium salt of diatrizoate solution), and Hypaque M or Renografin (mixture of methylglucamine and sodium salts of diatrizoate solution) in aortography, arteriography, and venography.

Observations were made on 230 patients. Forty-four aortographic studies were made in 36 patients, 95 peripheral arteriographic examinations were carried out in 68 patients, and 169 injections for phlebographic studies were performed in 126 patients.

In aortography the Renografin 75 per cent gave consistently satisfactory opacifications of the aorta and iliac and femoral arteries. In order to overcome the effects of dilution, as much as 35 c.c. was used when it was desirable to include the femoral and popliteal vessels of large patients. Hypaque Sodium was not available in concentrations higher than 50 per cent and at that dilution opacification was too faint even in cases with obstructive lesions. Miokon Sodium was unsatisfactory for aortic opacification, despite the availability of concentrations up to 90 per cent. All three preparations were well tolerated and the only overt reaction observed was an episode of coughing and vomiting after the injection of 35 c.c. of 75 per cent Renografin.

All three agents produced satisfactory opacification in peripheral arteriography although the diatrizoates seemed somewhat better than Miokon Sodium. Pain was never severe with Renografin despite the use of a 60 per cent solution, whereas severe pain was noticed in 4 of 41 cases where Hypaque Sodium was the agent and in 5 of 28 cases in which Miokon Sodium was used.

In phlebography, all three media seemed to produce good opacification. Severe pain and spasm followed the injection of Renografin in 1 case (2 per cent), of Hypaque Sodium in 5 cases (13 per cent), and of Miokon Sodium in 13 (16 per cent). Qualitatively, the difference between the Hypaque Sodium and Miokon Sodium seemed greater than indicated by the statistics.

On the basis of their experiences, the authors recommend the mixture of methylglucamine and sodium diatrizoate (Renografin) to replace the older, more toxic vascular opacification media, such as acetrizoate and iodopyracet. The optimum dosage and concentrations appear to be (*a*) 20 to 35 c.c. of a 75 per cent solution for aortography; (*b*) 7 to 12 c.c. of a 60 per cent solution for peripheral arteriography; (*c*) 20 to 25 c.c. of a 35 per cent solution for peripheral phlebography.

Four roentgenograms; 6 tables.

Difficulties in Roentgen Diagnosis of the Space-Occupying Lesions of the Atria of the Heart. E. Derra, F. Loogen, and H. Vieten. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 308–313, March 1959. (In German) (Medizinische Akademie, Düsseldorf, Germany)

Primary tumors of the heart originate either from the endocardium or myocardium. Seventy-five per cent of the heart tumors are benign—myxoma and fibroma, angioma, papilloma, and rhabdomyoma. The malignant tumors are sarcoma and hemangio-endothelioma. The favored location of the benign tumors is the left atrium and of the malignant neoplasms the right atrium. Myxomas are usually solitary and grow from the interatrial septum to the lumen. Thrombi (in the sense of space-occupying processes) occur mostly in the left atrium and originate from the auricular appendage.

Clinical symptoms depend on the location and size of the tumor. So long as there is no interference with the blood circulation no symptoms will occur. If the blood flow from the atrium to the ventricle is interrupted, the clinical features will be those of mitral or tricuspid disease, chiefly stenosis. Of clinical significance are disappearance of a murmur when the patient lies on his back, increase in shortness of breath with elevation of the trunk, and a failure of symptoms to become more severe with effort. Fluoroscopy shows no characteristic changes. The left ventricular enlargement and increased lung markings or enlarged right atrium with widening of the superior vena cava would speak for

mitral or tricuspid stenosis. Occasionally calcifications are observed within the tumor mass.

Catheterization is diagnostic only when the mass is mobile and blood flow can be prevented during the procedure. Intravenous angiograms show chamber enlargement but not its cause. The authors agree with Ellis *et al.* that angiograms are not satisfactory for differential diagnosis in left-sided lesions when the contrast material is injected into a peripheral vein.

Five roentgenograms. ILONA D. SCOTT, M.D.
Lewisburg, W. Va.

Right Atrial Myxoma. A Clinical Study of a Patient in Whom Diagnosis Was Made by Angiocardiography During Life. (Surgically Removed.) Harold A. Lyons, John J. Kelly, Jr., Nathaniel Nusbaum, and Clarence Dennis. Am. J. Med. **25:** 321–326, August 1958. (H.A.L., Kings County Hospital Center, Brooklyn 3, N. Y.)

A case of myxoma of the right atrium in a 51-year-old man is reported. The patient had progressive right-sided heart failure for five months. Clinically he appeared to have a tricuspid stenosis. On angiocardiography, a large nonopacified mass was demonstrated in the right auricle in both postero-anterior and right lateral views. This measured 9 × 11 cm. The superior vena cava was dilated; the right ventricle was never well opacified. A diagnosis of right atrial tumor was made, and at surgery a large myxomatous mass was found, obstructing the tricuspid orifice.

The authors emphasize that angiocardiography is essential for the diagnosis of an intracavitary cardiac tumor during life. Three cases of left atrial myxoma have been correctly diagnosed by Steinberg, *et al.* (Dis. of Chest **24:** 509, 1953. Abst. in Radiology **63:** 445, 1954).

Seven figures, including 3 roentgenograms.

The Growth of the Normal Aorta and of the Anastomotic Site in Infants Following Surgical Resection of Coarctation of the Aorta. Arthur J. Moss, Forrest H. Adams, Bernard J. O'Loughlin, and Wilfrid J. Dixon. Circulation **19:** 338–349, March 1959. (School of Medicine, University of California, Los Angeles, Calif.)

Normal aortic growth was studied in 154 patients with angiocardiography, ranging in age from two days to seventy-four years. Diameters were measured at the level of the diaphragm and corrected for distortion. Systolic measurements were used, averaging 1.3 mm. greater than diastolic. From birth to maturity the aorta increase was found to be threefold; at three years it is 55 per cent of adult size.

Five patients operated upon at the age of two weeks to twenty-two months for coarctation of the aorta were followed by postoperative angiocardiography at intervals up to four years. All showed some poststenotic dilatation and all but one had some constriction at the anastomotic site, suggesting the occurrence of varying degrees of growth deficit. In no case was the diameter at the anastomosis less than 55 per cent of the expected figure. None showed physiological evidence of obstruction.

Thus it appears that a properly done anastomosis at three years or older should remain adequate regardless of whether or not further growth occurs.

Eleven roentgenograms; 1 diagram; 7 graphs; 3 tables. ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Aneurysm of the Descending Thoracic Aorta with a Unique Electrocardiogram. M. G. Varadarajan. Current M. Practice (Bombay) **3:** 126–134, March 1959. (Stanley Medical College, Madras, India)

A case is described of an aneurysm of the descending thoracic aorta, demonstrated roentgenologically and proved at autopsy, though the electrocardiogram pointed to a diagnosis of aneurysm of the pulmonary artery, eroding the vertebrae.

Fluoroscopy demonstrated a slightly pulsatile soft-tissue mass continuous with the descending thoracic aorta and projecting posteriorly, more into the left than the right lung field. A lack of parallelism of the aortic walls was easily seen. There was a suggestion of dorsal vertebral involvement, confirmed by roentgenograms. The esophagus was displaced to the right in the left oblique view, slightly to the left in the right oblique and anterior views. The anterior surfaces of the seventh, eighth, and ninth dorsal vertebral bodies showed the typical erosion associated with aneurysm. On kymography the pulsations of the soft tissue mass were seen to be continuous with the descending thoracic aorta.

At autopsy, the aneurysm was found to involve the thoracic aorta from the level of the fourth dorsal vertebra to the hiatus in the diaphragm. It had ruptured into the left pleural cavity. The pulmonary artery was normal.

Four roentgenograms; 12 electrocardiograms.

Demonstration of Aneurysms of the Abdominal Aorta by the Catheter Method. W. Porstmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 190–195, February 1959. (In German) (Zentrales Röntgeninstitut der Charité, Berlin, Germany)

Aneurysms of the aorta in the thoracic region are almost always of syphilitic origin, and in the abdominal region of arteriosclerotic origin. The treatment of choice is surgical resection, usually with replacement of the resected part by an artificial tube of orlon, dacron, or nylon. If the resection is to be done above the level of the renal arteries, a collateral circulation must first be established. Below the renal artery the operation is much simpler, since the aorta may be clamped off for several hours and a collateral circulation is unnecessary.

Direct lumbar aortography with a needle in arteriosclerotic patients is not free from danger on account of possible bleeding from the puncture wound and the risk of separation of an arteriosclerotic plaque, which may produce an embolism. Much less dangerous is the catheter method devised by Seldinger, permitting the replacement of the puncturing cannula by a catheter of equal diameter. Introduction of the catheter into the femoral artery, however, is not always satisfactory. It may become stuck along the rough surface of the wall of the aneurysm and curl up, so that satisfactory filling is not obtained. Too much pressure cannot be applied on account of the danger of rupturing the aneurysm.

The author uses a different route, introducing the catheter into the left brachial artery, after percutaneous puncture. An opaque polyethylene catheter with a curved point is pushed, under fluoroscopic control, through the subclavian artery into the descending aorta down to the 12th dorsal vertebra, and the contrast material is injected rapidly (20 c.c. per second). An automatic injection outfit is used and the catheter has several openings along the side near the top to facilitate rapid flow. The retardation of the current in the aneu-

rysm helps to produce a satisfactory filling. The renal artery is usually well visualized, the upper end of the aneurysm, and part of the healthy aorta above can be seen satisfactorily, and the operation can be properly planned according to the involvement as seen in the aortogram.

The author presents one typical case.

Four roentgenograms; 2 photographs.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Separate Angiography of the Aortic Branches with Percutaneous Catheter Insertion: Indications and Results. G. Gollmann. Fortschr. a. d. Geb. d. Röntgenstrahlen **89**: 383–396, October 1958. (In German) (Landeskrankenhaus Graz, Graz, Austria)

For angiography of the branches of the aorta, the author uses 20 c.c. of a 50 to 70 per cent contrast material, which he injects manually. Under local anesthesia, the femoral artery is punctured with a needle having a lumen of 1.6 or 2.0 mm. Through this a guide wire is passed and over the wire a polyethylene catheter is inserted, after removal of the needle, and advanced until it reaches the desired position.

Unilateral renal angiography is indicated for avoidance of injury to the opposite kidney, demonstration of a small renal lesion, and when blood flow through the kidney is believed to be impaired.

Celiac artery catheterization permits demonstration of the splenic artery and vein with a single injection; 20 c.c. is introduced in five or six seconds, and the splenic vein can be seen eight to twelve seconds later.

Angiography of the stomach, liver, and pancreas up to the present has been less satisfactory than renal angiography. The method has been used also for catheterization of the subclavian and vertebral arteries.

Altogether 700 cases have been examined by this technic, but its use is advised only when specifically indicated and when simpler examinations are inadequate for a diagnosis.

Nineteen roentgenograms; 4 drawings.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

Dissecting Aneurysms of the Carotid Artery Following Arteriography. J. F. Ross Fleming and Andrew M. Park. Neurology **9**: 1–6, January 1959. (Toronto Western Hospital, Toronto, Ont., Canada)

It is well known that local complications may result from percutaneous carotid arteriography, such lesions including thrombus formation at the puncture site, formation of false aneurysm, carotid-jugular fistula, and creation of an intimal flap occluding the lumen as a valve. A less commonly reported complication is dissecting aneurysm in the wall of the artery at the site of needle puncture. The authors report 2 such cases. In one patient the artery was narrowed sufficiently to produce massive cerebral infarction; in the other, the hemorrhage was small and was an incidental autopsy finding.

Review of several large autopsy series would indicate that in some 10 per cent of patients subjected to carotid arteriography a small dissecting aneurysm develops. On the contrary, lesions large enough to narrow the lumen severely, causing symptoms, are extraordinarily rare. Even the smallest intimal elevation may, however, become the site of thrombus formation and thus a possible source of emboli.

A significant finding in one series was the frequent presence of small lacerations of the intima of the wall opposite the puncture site. This indicated that the artery was almost always transfixed by the needle.

A dissecting aneurysm may be produced at either the puncture site, or the site of perforation of the intima of the posterior artery wall. The latter location is considered by the authors the more probable.

Considering the relative rarity of postarteriographic dissecting aneurysms in man and apparent inability to produce the condition in dogs, it seems likely that other factors in addition to the mechanical must play a part in predisposing to the formation of this lesion. An artery wall made friable by atheroma, an elevated blood pressure, or an abnormal bleeding tendency may be important in this respect. The increased risk of subjecting patients with arterial disease to arteriography should be fully realized. Further, the clinician should be alert to the complication of dissecting aneurysm, which may explain certain postarteriographic symptoms and may elucidate the interpretation of incomplete filling of the carotid artery in some cases.

Seven roentgenograms; 3 photomicrographs; 3 photographs; 3 drawings.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

Iliofemoropopliteal Arterial Reconstructions for Arteriosclerosis Obliterans. Factors Influencing Late Patency. Richard Warren and J. Leonel Villavicencio. New England J. Med. **260**: 255–263, Feb. 5, 1959. (Harvard Medical School, Boston, Mass.)

Seventy patients in whom iliofemoropopliteal arterial reconstructions were done for obliterative arteriosclerosis, with the upper end of the reconstruction below the origin of the external iliac artery, were followed for at least a year. The patency of reconstructed segments was found to vary between 12 and 62 per cent if the early failures were included, and between 27 and 84 per cent in those patients who left the hospital with patent segments. The incidence of patency for the entire series was 55 per cent following thrombendarterectomy, 18 per cent after venous homografts, and 9 per cent for arterial homografts. In patients leaving the hospital with a patent segment and followed for a year, these percentages are 61, 20, and 13, respectively.

Seventeen arteriograms taken before closure of the reconstruction were available and were examined for abnormalities such as stenosis, irregularity, and aneurysm formation. There were lesions in 3 of 6 arterial homografts, in all of 7 venous autografts, and in 2 of 4 thrombendarterectomies.

Roentgen and pathologic study showed the thrombendarterectomized segments to undergo a marked fibrotic reaction during the first six months after surgery. If they survived this period, further reaction did not take place, and relatively long-term patency could be expected. With venous autografts, also relatively long-term patency could be expected if closure did not take place in the first six months from a constriction of the anastomosis, irregularity of the segment itself (due to valve stations), taut adventitial bands, and external hematomas. Lesions were seen in half the cases in which arterial homografts were used. These consisted of mural thrombus, rapid degeneration with calcification, aneurysm, and late degeneration similar to arteriosclerosis. Later closures occurred in these segments, and in others that showed no lesions, to the extent that

no security against closure was gained with the passage of time.

Twenty per cent of the limbs in which the reconstructions closed became worse. Of these, about half required amputation, which probably would not have been necessary if reconstruction had not been attempted.

Eighteen roentgenograms; 5 tables.

Arteriosclerosis Obliterans of the Lower Extremity. Donald J. Lulu. J. Iowa State M. Soc. **49:** 90–94, February 1959. (VA Hospital, Des Moines, Iowa)

Arteriosclerosis obliterans of the lower extremity may be segmental or diffuse. The treatment of choice for the segmental type in which arteriography demonstrates an adequate degree of patency in the arterial tree distal to the site of occlusion is an end-to-side bypass graft. The addition of lumbar sympathectomy at the time of grafting affords added protection to the extremity. The only surgical treatment short of amputation that can be given the patient with the diffuse type of involvement is lumbar sympathectomy, a procedure which allows more blood to reach the ischemic limb by dilating the collateral vascular channels.

Since late in 1956 the author and his co-workers have obtained arteriograms routinely at the time of lumbar sympathectomy in an attempt to correlate the site and type of occlusion with the results of sympathectomy and also to select candidates for direct surgical attack. The patient is first tested for sensitivity to the medium, and lumbar sympathectomy is performed under spinal anesthesia. If no allergy is demonstrated, 10 c.c. of 50 per cent Hypaque is injected into the common iliac artery, and a roentgenogram is made with a portable x-ray unit. On occasion, an aortogram has been obtained following injection of 25 to 30 c.c. of 50 per cent Hypaque into the distal aorta when a left-sided sympathectomy has been performed. To date, there has been no mortality or morbidity in over 60 such procedures. The series is as yet too small to permit definite conclusions, but it is believed that the method warrants further consideration.

Five illustrative case reports are given.

Ten roentgenograms; 2 photographs.

THE BREAST

X-Ray Examination of the Breast. David M. Sklaroff, Simon M. Berger, and Victor Kremens. J. Canad. A. Radiologists **10:** 13–16, March 1959. (Albert Einstein Medical Center, Philadelphia 41, Penna.)

Complexities of technic, the unfamiliarity of the radiologist with the normal radiographic appearance of the breast, and difficulties in co-ordinating the x-ray finding with the different conceptions of pathologists, explain the limited acceptance, to date, of mammary roentgenography.

Accuracy of demonstration of the breast on the x-ray film depends chiefly on the contrast afforded by the fat which is present. Among the benign diseases, those with multinodular changes are the most difficult to diagnose. Malignant lesions are of three types—scirrhus, circumscribed or medullary, and intraductal—each of which has its characteristic roentgen features. The scirrhous type shows irregular, spiculated margins with some slightly increased density, distortion of the perifocal surrounding breast tissues, and a mass measuring less on the film than it does clinically. In the circumscribed or medullary type the growth is characterized by well circumscribed smooth margins, which, however, on close inspection will be found in some portion to exhibit irregularity as a result of infiltration into the surrounding parenchyma. Intraductal carcinomas show irregularly distributed punctate crystalline calcific deposits.

The authors summarize their experience in a thousand cases and conclude that the trained roentgenologist should be able to make a diagnosis of breast disease in 80 per cent of cases.

Three roentgenograms; 3 photographs; 1 table.

CARL J. PONISCHIL, M.D.
Cleveland Metropolitan General Hospital

THE DIGESTIVE SYSTEM

Gastrografin as Water Soluble Contrast Medium in Roentgen Examination of the G.I. Tract. Franz P. Lessman and Ralph M. Lilienfeld. Acta radiol. **51:** 170–178, March 1959. (Roswell Park Memorial Institute, Buffalo, N. Y.)

Gastrografin 76 per cent, an organic iodide in a palatable aqueous solution, was evaluated as the sole contrast medium in radiography of the gastrointestinal tract of 40 patients. Mucosal detail was not as well demonstrated as with barium sulfate, possibly because a suspension is superior to a solution for mucosal studies. Gastrografin is the medium of choice when prolonged retention of contrast medium within fistulous tracts, body cavities, or bowel lumen is anticipated, and in those conditions in which the possibility of aspiration of contrast medium exists. An additional 35 patients were examined by a combination of diluted Gastrografin and barium in a preliminary investigation which indicated that this combined medium deserves further evaluation.

This medium, being hypertonic, is similar in action to saline cathartics and in the authors' opinion its oral use is contraindicated in any condition in which the use of a cathartic is likewise contraindicated. Its use is hazardous, also, in any case in which the possibility of acute appendicitis or of complete mechanical bowel obstruction enters into the differential diagnosis.

Ten roentgenograms; 1 table.

GEORGE L. SACKETT, M.D.
Cleveland, Ohio

Postoperative Gastro-Intestinal Roentgenography. Herbert Greenfield. J. M. Soc. New Jersey **56:** 128–130, March 1959. (31 Lincoln Park, Newark, N. J.)

Early postoperative roentgen studies following colonic and gastric surgery are strongly advised. With immediate postoperative films at hand, x-ray misinterpretation and further surgery may be avoided years later when ulceration at the anastomotic site or the development of a carcinoma on a gastric stump are thought possible.

Four cases are recorded to illustrate the value of such repeated early post operative studies. Exclusion of a neoplasm would have been difficult, if not impossible, in these instances without earlier films following operation for ulcer (2 cases), sigmoid carcinoma (1 case), and gastric adenocarcinoma invading the esophagus (1 case).

Four roentgenograms.

A Case of Idiopathic Muscular Hypertrophy of the Esophagus. J. De Backer. J. belge de radiol. **42:** 217–222, 1959. (In French) (Ghent, Belgium)

Idiopathic muscular hypertrophy of the esophagus is a rare disease. The author describes a case which he examined radiologically, demonstrating a marked stenosis of the esophagus, stasis of barium, and dilatation proximal to the area of narrowing. He adds the surgical and anatomico-pathological findings.

Only one other case has been published in which the diagnosis was made with the patient still living (Sloper: Thorax **9:** 136, 1954).

Two roentgenograms; 1 drawing.

RENE HOURI, M.D.
New York, N. Y.

Roentgenological Contributions to the Diagnosis of Gastro-Intestinal Allergies. F. Tiemann and H. Lenz. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 351–360, March 1959. (In German) (Medizinische Univ.-Poliklinik, Bonn, Germany)

Roentgen examination has great importance in the diagnosis of gastrointestinal allergies: (1) Through contrast examination, diseases of the gastrointestinal tract and gallbladder can be excluded. (2) Functional disturbances furnish an important clue to the presence of gastrointestinal allergies, especially in the small intestine. (3) Clinical and roentgenologic suspicions can be validated and findings may be reproduced by "exposition-trials."

The authors discovered 21 cases of gastrointestinal allergy in 1,000 examinations of the stomach and small bowel. When suspicious roentgen signs were found, a careful history was taken and the patient was put on an elimination diet. Skin tests were found not to be reliable in gastrointestinal allergies. A simple method for exclusion of the allergen was used, which has been recommended also by others. This consists in counting the pulse rate after each test meal. If the rate is increased by 14 or more, the presence of an allergen is assumed. The patient is kept on the allergen-free diet for six to eight days, and, if the roentgen control is normal, the allergic symptoms are then reproduced by the addition of the allergen to the barium meal. Films are made at half-hour intervals, two to three films usually being enough for the complete visualization of the small intestine.

The authors report 5 cases. The accepted roentgen signs of antral and pyloric spasm and edema of the stomach were seen in only a few cases. More often the stomach shows disturbances of tone and motor function: either as hypertonus with lively peristalsis or hypomotility with dilatation. The mucosa resembles that in simple gastritis with increased gastric secretion.

The changes in the small intestine are more striking. There is a marked disturbance of tone and motor function with an extreme increase of motility. Other characteristic signs are activity, spasm with segmentation, increased secretion with gas formation and distention of the small intestinal loops, swelling of the submucosa and of the entire intestinal wall.

Eleven roentgenograms.

ILONA D. SCOTT, M.D.
Lewisburg, W. Va.

Carcinoma Following Gastric Operations for Non-Malignant Diseases. H. Gremmel, W. Schulte-Brinkmann, and H. Vieten. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 342–350, March 1959. (In German) (Medizinische Akademie, Düsseldorf, Germany)

The first cancer following gastroenterostomy for benign ulcer is said to have been reported in 1926. Wolfsohn in 1928 re-examined 1,200 cases in which gastroenterostomy had been performed and found no cancer, whereupon he concluded that a cancer-inhibiting substance exists in the small intestine within the range of the anastomosis.

In the last ten to fifteen years several primary carcinomas following gastric operations for benign conditions have been reported. Theories as to the etiology of the postoperative gastric carcinoma differ. Kühlmayer and Rokitansky (Dentsche Ztschr. f. Chir. **278:** 361, 1954) thought that the altered physiological conditions following resection increased the possibility of cancer formation in the fundus ten times. Others have assumed that a carcinoma was originally present, either instead of the supposedly benign lesion or in addition to it. Again, it has been concluded that a peculiar disposition to the development of cancer exists in the postoperative stomach. The presumptive causes are: anacidity, regurgitation of the intestinal juice into the gastric stump, mechanical overload, and chronic gastritis.

Roentgenologically it is difficult to demonstrate a tumor following gastric resection because of the changed topographic conditions at the site of the anastomosis. It is also hard to demonstrate small tumor masses in the remainder of the stomach, since frequently the emptying time is increased. It is easier to make a diagnosis of carcinoma in the vicinity of the cardia, as this will produce some narrowing of the cardiac portion of the stomach with moderate dilatation or rigidity of the distal esophagus. Delay in passage of contrast material points to such a change. Attention has also been called to marked widening of the anastomotic ring and a hard marginal wall as a sign of carcinoma.

The authors found 13 primary carcinomas in 1,709 cases following operation on the stomach. The original operations were performed for non-malignant conditions—gastric and duodenal ulcers, in the ratio of 3:1—at least six years before cancer developed (average eighteen years). The 13 carcinomas represent approximately 1 per cent of all stomach operations.

Three roentgenograms; 2 tables.

ILONA D. SCOTT, M.D.
Lewisburg, W. Va.

Malignant Tumours of the Small Bowel. Robert Lessard. J. Canad. A. Radiologists **10:** 8–12, March 1959. (Hôtel Dieu, Quebec, Que., Canada)

The low incidence of malignant tumors of the small intestine is well known. The general clinical symptoms are those common to all cancers, as anorexia, loss of weight, and anemia. Para-umbilical pain is a rather constant symptom; intestinal obstruction and the passage of red blood when the colon examination is negative are also suggestive.

The radiologic signs differ with the type of tumor. In adenocarcinoma there is annular constriction with mucosal destruction and ulceration, at times with a fungoid mass. A single short segment is involved. In lymphosarcoma a narrowing simulating the stenosis of ileitis or of adenocarcinoma can be seen. More often there is a sausage-like dilatation of an intestinal coil between two narrowed segments. The walls

are rigid, with jagged edges. The mucosa is destroyed and obliterated, with digital prints and pebbled surface. The diseased coil is isolated from the other coils and there is a palpable corresponding mass. Carcinoids may produce signs of compression at the cecal level. Conditions to be differentiated from primary malignant lesions are metastatic narrowings, benign tumors, extrinsic compression, regional ileitis, and tuberculosis.

Three cases are reported. All exhibited the radiologic signs of jejuno-ileal tumors, and in all the diagnosis was proved at operation.

Eleven roentgenograms.

CARL J. PONISCHIL, M.D.
Cleveland Metropolitan General Hospital

Reticulum-Cell Pathology and the Phenomenon of Lymphatic Pseudopolyposis of the Ileum. H. Uthgenannt. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 151–164, February 1959. (In German) (Krankenhaus Süd, Lübeck, Germany)

Polypoid changes in the terminal ileum have been described as occurring in terminal ileitis, but they may be a manifestation of other pathological processes. In young girls (ages ten to twenty years) with pain in the right lower abdomen, filling defects ranging from 1 to 5 mm. in diameter can be seen in roentgenograms of the terminal ileum, later on disappearing without subsequent sclerosis. It is assumed that these filling defects are the result of a localized lymphatic hyperplasia, due to some toxic or bacterial infection. The names given this condition are: "cobblestone ileum," non-sclerosing ileitis, pseudopolyposis lymphatica ilei, enteritis follicularis.

The author has routinely examined the terminal ileum in all juvenile and adult patients with scarlet fever, Pfeiffer's glandular fever, infectious mononucleosis, and acute tonsillitis (due to bacterial as well as virus infection). In such cases with clinically demonstrable lymphadenitis of the head and neck region, he has almost always found definite changes in the mucosal pattern of the terminal ileum. He is convinced that these changes, closely resembling the lymphatic pseudopolyposis of the ileum in children, represent organic disease and are not merely physiological. He believes they are due to an infectious or toxic reticulum-cell reaction. In adults these polyp-like changes disappear with the termination of the underlying disease; in children they last longer but finally also disappear. Lymphatic polyposis of the ileum has likewise been reported in measles, German measles, and other virus infections.

The author has also studied the ileum in a number of cases of sarcoma. His series includes polymorphous-cell reticulo-endothelial sarcoma and small-cell lymphosarcoma. In both groups he was able to demonstrate polypi. In the cases of lymphosarcoma the polypi are larger and more numerous. X-ray treatments will lead to disappearance of the polypi and restitution of a normal mucosal pattern.

Fourteen roentgenograms; 2 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

A New Technique for the Study of the Colonic Mucosa. Paul H. Kronenberger. Indian J. Radiol. **13:** 25–36, February 1959. (St. George's Hospital, Bombay, India)

In order to obtain a more satisfactory demonstration of the colonic mucosa, the author devised a technic in which a minimal amount of barium is introduced into the sigmoid under fluoroscopic control prior to the routine examination. This method was employed in the study of 160 cases, including both normal conditions and practically all of the common functional disorders and organic lesions of the colon.

As a rule, the preliminary films allow a much better visualization of the mucosal pattern and disclose more details, especially in the iliac and descending portion, than do conventional postevacuation roentgenograms. The method appears to be of particular value in various motor disturbances and for exploration of the mucosa in circumscribed portions of the bowel, as in ileocecal tuberculosis, diverticulitis, tumors, and the anastomotic region following colectomy.

With this new technic the radiologist is usually able to distinguish between functional disorders of the colon and inflammatory changes, a differential diagnosis of great importance in tropical countries, where motor disturbances frequently occur.

Thirty-four cases are reported, with clinical, pathological, and sigmoidoscopic data.

Eighteen roentgenograms.

An Evaluation of the Roentgen Changes in Acute Pancreatitis: Correlation with Clinical Findings. George N. Stein, Martin H. Kalser, Norair N. Sarian, and Arthur Finkelstein. Gastroenterology **36:** 354–361, March 1959. (Graduate Hospital, 19th and Lombard Sts., Philadelphia 46, Penna.)

The authors analyzed the roentgenograms of 66 patients with 73 hospital admissions for acute pancreatitis and acute relapsing pancreatitis. The most frequent and most reliable roentgen sign of the disease was the presence of the so-called "sentinel loop" in the left midabdomen or left upper quadrant. Pancreatic calculi or calcifications were present in less than 20 per cent of the cases but when present were highly significant. An enlarged papilla of Vater was noted in 25 per cent of the patients having barium meal studies. This was considered an important sign but not pathognomonic. Other abnormalities demonstrated on the survey films of the abdomen occurred too infrequently or were too non-specific to be of value. Corroborative evidence was obtained from chest films in 18 of 40 patients examined but was not specific.

Six roentgenograms; 7 tables.

R. S. ORMOND, M.D.
The Henry Ford Hospital

Technique, Hazards, and Usefulness of Percutaneous Splenic Portography. William F. Panke, Edward G. Bradley, Augusto H. Moreno, Francis F. Ruzicka, Jr., and Louis M. Rousselot. J.A.M.A. **169:** 1032–1037, March 7, 1959. (L. M. R., 170 W. 12th St., New York 11, N. Y.)

The major usefulness of percutaneous splenic portography, *i.e.*, diagnostic injection of a radiopaque solution into the spleen, has been in the diagnosis of portal hypertension. Information as to extent of "extrahepatic collateralization," major vessel size, portal and/or splenic vein thrombosis, and compression or invasion of major portal radicles may also be obtained, and portacaval shunts may be evaluated.

The authors' experience includes 172 multiple-exposure serial percutaneous splenic portograms.

Their technic is described in detail. The patient is hospitalized; normalcy of blood-clotting mechanism is ascertained by laboratory tests. Sterilization of the colon is attempted where possible, and colon irrigation is performed prior to the procedure. The patient is instructed to avoid deep respiration during the time the needle is in the spleen. Scout filming of the abdomen and fluoroscopic examination are helpful in selecting the site for splenic puncture. Usually, this is at the ninth intercostal space in the posterior axillary line. An 18-gauge spinal needle with stylet is introduced into the splenic pulp and directed toward the hilus. Manometric readings are taken. A test injection of 5 c.c. of 70 per cent sodium acetrizoate is made and satisfactory position of the needle tip is ascertained fluoroscopically. Forty cubic centimeters of solution are then rapidly injected (in eight to twelve seconds), and 14×17-inch films are manually shifted through the Bucky slot and exposed at two, four, six, eight, twelve, sixteen, twenty-four, and thirty-two seconds from the beginning of the injection.

Contraindications to portography are: marked alteration of the blood-clotting mechanism, history of allergy, inability of the patient to co-operate, and tumors of the spleen. Inherent dangers of the procedure must be realized, but these hazards may be minimized by adherence to details of proper technic. Complications that may be anticipated are: allergic reactions, pain, bleeding, infection, faulty puncture, and thoracic complications.

Seven roentgenograms; 1 photograph; 1 diagram.

WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

Congenital Absence of the Gallbladder. Diagnosis by Operative Cholangiography. Charles L. Geraci. Arch. Surg. **78:** 437–439, March 1959. (1303 San Carlos Ave., San Carlos, Calif.)

Congenital absence of the gallbladder is a rare congenital anomaly usually discovered at autopsy or during surgery, the incidence being given, in autopsy series, at 0.03 to 0.09 per cent. A familial occurrence has been reported (Kobacker: Ann. Int. Med. **33:** 1008, 1950). About half of the patients have symptoms of biliary disease or jaundice. Diagnosis of agenesis of the gallbladder cannot be made preoperatively. Even during surgery, exploration is not enough to confirm the anomaly. Cholangiography should be performed to outline the biliary tree for definite diagnosis.

The author reports a case which he believes is the second to be proved by operative cholangiography. (For a third case see the following abstract.)

One roentgenogram.

J. S. ARAJ, M.D.
Toledo, Ohio

Congenital Absence of the Gallbladder. John F. Carnevali and Carl A. Kunath. Arch. Surg. **78:** 440–445, March 1959. (C. A. K., Goodfellow AFB, San Angelo, Texas)

Absence of the gallbladder is a rare congenital anomaly attributed to an abnormality in embryonic development; 122 cases are said to have been recorded in the literature. The authors report the case of a 29-year-old male with symptoms of cholecystitis and three cholecystographic examinations reported as showing a nonfunctioning gallbladder. Surgery was performed, but the gallbladder could not be identified on inspection. Cholangiography showed normal hepatic and common bile ducts but no trace of a cystic duct or gallbladder.

Absence of the gallbladder is often accompanied by symptoms and signs suggesting biliary disease, which, with the finding of a nonfunctioning gallbladder on cholecystography, bring the patient to surgery. Cholangiography will confirm the condition. Most authors agree that the best treatment is T-tube drainage of the common bile duct even though this is not dilated and stones are not detected.

One roentgenogram.

J. S. ARAJ, M.D.
Toledo, Ohio

Double Gall Bladder. Report of One Asymptomatic Case Demonstrated Roentgenologically. A. Glay. J. Canad. A. Radiologists **10:** 1–3, March 1959. (St. Mary's Hospital, Montreal, Que., Canada)

A double gallbladder is a rare congenital anomaly, the estimated number of published cases up to 1955 being about 50. The author reports a case in a 54-year-old white male without symptoms, in whom routine cholecystograms disclosed two distinct gallbladders adjacent to each other. Both showed good concentration of the contrast medium, as well as good response to cholecystokinetic fatty stimulus.

The double gallbladder does not, *per se*, cause symptoms. However, both organs are subject to the same disease process as a single organ. Only occasional puzzling diagnostic difficulties may be encountered.

Five roentgenograms.

CARL J. PONISCHIL, M.D.
Cleveland Metropolitan General Hospital

Hematemesis Associated with Hemobilia: Report of a Case Due to an Intrahepatic-Artery Aneurysm, with Survival. Albert G. Mackay and H. Gordon Page. New England J. Med. **260:** 468–471, March 5, 1959. (University of Vermont College of Medicine, urlington, Vt.)

The authors report what they believe to be the first recorded case of an intrahepatic aneurysm causing hemobilia, diagnosed by angiography and followed by cure.

The patient was a 29-year-old housewife. Six weeks after cholecystectomy, repeated hematemesis led to a subtotal gastrectomy, which was carried out on an empirical basis since no other cause of hemorrhage could be found. Reoperation was necessary eleven days later, following another episode of massive bleeding. When the duodenum was opened on this latter occasion, a black mass was seen to protrude from the ampulla of Vater. This proved to be a dark blood clot. On its release from the ampulla, a spurt of arterial blood occurred under pressure in the biliary tract. Biopsy and frozen section of the ampullary area gave no evidence of tumor. An operative cholangiogram showed no indication of disease. The hepatic artery appeared normal. A tube was placed in the common duct and the abdomen closed.

Seven days later, brisk arterial bleeding recurred through the T tube, and the abdomen was again explored. An operative portogram showed a normal portal venous system. The common hepatic artery was next injected with 10 ml. of 35 per cent sodium acetrizoate, but only the left artery was visualized. On the right there was definite pooling of the contrast medium, typical of a well formed aneurysm of the right

hepatic artery within the substance of the liver. This artery was ligated, and with high doses of antibiotics and supportive therapy, the patient made an uncomplicated recovery. Nine months after surgery, liver function tests were within normal limits.

The diagnosis of hemobilia is practically impossible without surgical exploration. If an intrahepatic aneurysm is discovered, the ligation of the involved hepatic artery is the probable procedure of choice.

Five roentgenograms.

Oral Cholangiography: A Method of Visualizing the "Nonvisualized" Gallbladder. J. Russell Twiss and Lee Gillette. J.A.M.A. **169:** 1275–1278, March 21, 1959. (L. G., 850 Park Ave., New York 21, N. Y.)

The authors' technic of oral cholangiography calls for the administration of 6 tablets of iopanoic acid at seven o'clock (after a six o'clock supper) on the evening before the x-ray examination and again half an hour later. No breakfast is allowed on the day of the examination, and at 7 A.M. the patient receives 6 more iopanoic acid tablets. Paregoric is given after the second and third doses. Roentgenograms are made at 10:00 and 11:00 A.M. and at noon. If there is no visualization of the bile ducts, the films are repeated twenty-four hours later.

Forty-six patients in whom routine cholecystography had failed to give satisfactory visualization of the gallbladder or bile ducts were selected for oral cholangiography. Visualization of the gallbladder or of the common duct, with stones, was obtained in 23 patients. The roentgen findings were confirmed in 17 of 18 patients in this group in whom surgery was performed. In 12 patients stones were not demonstrated, although the gallbladder (but not the common duct) was visualized. Surgery was performed in 3 instances: 2 patients had stenosis of the common duct sphincter without stones and 1 had acute cholecystitis with a stone in the common duct. Eleven patients had no visualization of the gallbladder; 8 of these were operated upon, and all proved to have cystic duct obstruction. Opacification of the common duct was noted in 6 of the group of 11.

The authors feel that information afforded by oral cholangiography after failure of visualization by oral cholecystography may spare the patient an unnecessary operation. Useful diagnostic information may be obtained in hepatic disorders without jaundice, catarrhal cholecystitis, pathological cystic ducts, chronic cholecystitis, and chronic cholecystitis with choledocholithiasis. In certain cases the method described may be combined with intravenous cholangiography.

Nine roentgenograms. WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor, Mich.

Orabilex. Evaluation of a New Cholecystographic Medium. Galen M. Tice. J. Kansas M. Soc. **60:** 118–120, March 1959. (University of Kansas Medical Center, Kansas City 12, Kans.)

One hundred and fifty-two cholecystographic examinations with Orabilex are reported. The physical and chemical properties of this new medium are described. Brief studies of its toxicity in animals are reported.

The patients were given the manufacturer's recommended dose, and cholecystography was performed in the usual manner. None of the side-effects were serious; mild nausea was described by 17 per cent of the patients examined. The author grades 79 per cent of the resulting cholecystograms as excellent or good and only 3 per cent as poor. Patients were not customarily given a cholagogue but, when this was added, duct visualization tended to be improved. Pathologic findings in the cases studied are presented in tabular form.

The author concludes that Orabilex is a useful and satisfactory agent for cholecystography. With this preparation there is a lack of dissemination of particulate radiopaque material in the bowel which with other media occasionally causes overlying densities. Orabilex is eliminated largely through the urinary tract, in contrast to the intestinal excretion of other media, so that confusing bowel shadows seldom arise.

Eight roentgenograms, 3 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

THE MUSCULOSKELETAL SYSTEM

Skeletal Changes in Urticaria Pigmentosa. E. Bürgel and H.-G. Oleck. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 185–190, February 1959. (In German) (Wenckebach-Krankenhaus, Berlin-Tempelhof, Germany)

Urticaria pigmentosa, formerly considered to be solely a skin disease, is actually a systemic condition which may show involvement of the liver, the spleen, and the lymphatic, gastrointestinal, and skeletal systems. The skin changes consist in yellowish-brown spots or infiltrations ranging in size from a pinpoint to 1.5 cm. in diameter. They occur on the trunk and on the extremities and may show a hemorrhagic appearance. Histologically they represent an accumulation of mast cells, which contain histamine and heparin. The histamine when liberated produces wheals and blisters. The heparin, being an anticoagulant, explains the hemorrhagic appearance.

Skeletal involvement is not always present. It may be osteosclerotic or osteoporotic, or a mixture of both. The osteosclerotic changes may consist of small compact endosteomas or they may be generalized, sometimes symmetrical. Large sections of the skeleton may be involved, presenting the appearance of marble bones. The osteoporotic forms are characterized by decalcifications, leaving a coarse mesh of trabeculae. Both forms are said to be caused by mast cells.

The other systemic effects—enlargement of the liver, spleen, and lymph nodes—are probably also caused by mast cells; the gastrointestinal disturbances are most likely due to the action of histamine upon the smooth musculature. Inasmuch as the mast cells seem to be the underlying cause of all the changes, the term "mastocytosis" has been suggested for this disease.

The authors describe one case in detail.

Four roentgenograms.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Radiological Manifestations in Tuberose Sclerosis. P. H. Whitaker. Brit. J. Radiol. **32:** 152–156, March 1959. (University of Liverpool, Liverpool, England)

The author gives an account of the radiologic changes which may be found in patients suffering from tuberous

(or tuberose) sclerosis. After a short historical review he summarizes the findings as follows:

1. Visceral changes, as adenoma of the kidney and of the bowel and duodenum, cystic changes in the lungs, and liver and cardiac muscle defects.
2. Cerebral changes, consisting in calcifications in areas of gliosis in the cerebrum.
3. Skeletal abnormalities.

This paper is concerned with the skeletal changes, which may be fibrocystic, cystic, or sclerotic. Three cases are reported.

Eleven roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Radiological Bone Changes in Tuberose Sclerosis. T. Desmond Hawkins. Brit. J. Radiol. **32:** 157–161, March 1959. (Manchester Royal Infirmary, Manchester, England)

The author reports on 3 adult patients who exhibited some, or all, of the clinical features of tuberous (or tuberose) sclerosis. The main radiological bony changes are described. The lesions in the calvarium, hands, and feet are reported to be of diagnostic value, while those elsewhere in the skeleton are considered by the author to be less characteristic. He suggests the term "cortical pitting" to describe the changes in the cortex of the shaft of the phalanges.

According to Berland (Arch. Neurol. & Psychiat. **69:** 669, 1953. Abst. in Radiology **62:** 624, 1954), the combination of the intracranial calcification and osseous lesions in the hands and feet may be found in 60 to 65 per cent of patients with this disease, and Holt and Dickerson (Radiology **58:** 1, 1952) in a series of 45 patients found skull vault changes in 40 per cent of those who were radiographed. Tuberous sclerosis may occur in an atypical or incompletely developed form (*forme fruste*), the presenting symptom being epilepsy. It is in these cases that the radiological bone changes may be of value in establishing and substantiating the diagnosis.

Nine roentgenograms.

JULIAN O. SALIK, M.D.
Baltimore, Md.

Microradiographical Data on Fine-Fibered Bone. F. Bohatirchuk. Anat. Rec. **133:** 203–217, February 1959. (Department of Anatomy, University of Ottawa, Ottawa, Ont., Canada)

Serial sections of undecalcified human vertebral bone ten microns or less thick were studied by microradiography and stain historadiography (see Bohatirchuk: Stain Technol. **32:** 67, 1957. Abst. in Radiology **70:** 304, 1958). Approximately 1,000 microradiographs of human vertebrae at various ages and 300 stained specimens of the same bones were examined. For the radiographs the bone specimen was placed in close contact with a fine-grain photoemulsion film exposed to x-rays generated at 8 to 12 kv.

The microanatomy as demonstrated on the resulting radiographs is described in detail and illustrated by reproductions of the original films. There are shown varying degrees of x-ray absorption by adjacent strata of fine-fibered bone, explained on the basis of varying calcium content as well as differing structure. These studies give evidence that the bone fiber is the principal bearer of calcium rather than the structureless ground substance ("cement"), as has been suggested by earlier studies. It is also demonstrated that the calcified fine fibrils are quite flexible. It still seems probable, however, that some calcium is laid down in the ground substance in varying amounts.

Eleven microradiographs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Unusual Skeletal Dystrophy Associated with a Soft-Tissue Tumor. A. C. Bingold. Brit. J. Surg. **46:** 462–465, March 1959. (Lewisham Hospital, London, England)

The history is presented of a 14-year-old boy with multiple bony abnormalities and malformations of the bones associated with a large benign soft-tissue tumor (a hamartoma).

The bony defects consisted of fusion and irregular development of carpal and tarsal bones as well as premature fusion of the lower humeral epiphyses and dislocation of both elbows. Both wrist joints showed gross changes.

Since the bony changes were symmetrical, they are believed to have been due to a congenital developmental error. It is considered likely that the condition may have been familial, although this was not definitely proved. The association of a soft-tissue hamartoma and skeletal anomalies in this case is comparable to the findings in such conditions as congenital neurofibromatosis and Maffucci's syndrome.

Nine roentgenograms; 1 photomicrograph; 1 photograph.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Calcification of Intervertebral Disks in Children. A. Asadi. J. Dis. Child. **97:** 282–286, March 1959. (University Hospital, Ann Arbor, Mich.)

Two additional cases of symptomatic calcification of intervertebral disks in children are added to the growing literature. Both cases followed trauma to the back. The first patient was an 8-year-old Negro boy with acute back pain associated with muscular spasm. Roentgenograms revealed calcification of the nucleus pulposus between T-12 and L-1. Possible causes apart from trauma were ruled out by a variety of diagnostic tests. Treatment was by aspirin and a body cast for six weeks. Follow-up films over a two-month period showed gradual diminution in the extent of calcification.

The second patient was a 13-year-old colored boy with calcification of the 5th and 6th thoracic disks. Laboratory studies were negative; no follow-up was obtained.

Eight roentgenograms.

R. S. ORMOND, M.D.
The Henry Ford Hospital

Xeroroentgenography: An Evaluation of its Use in Diseases of the Bones and Joints of the Extremities. Crawford J. Campbell, John F. Roach, and Munir Jabbur. J. Bone & Joint Surg. **41-A:** 271–277, March 1959. (721 Madison Ave., Albany 8, N. Y.)

In 1957 (J. Bone & Joint Surg. **39-A:** 577, 1957. Abst. in Radiology **70:** 620, 1958), the authors reported the results of a comparative study of xeroroentgenography and routine roentgenography for recording images of bone specimens. The technic of xeroroentgenography was described earlier (Arch. Surg. **69:** 594, 1954. Abst. in Radiology **65:** 312, 1955). The present paper is concerned with a clinical evalua-

tion of xeroroentgenography as applied to the bones and joints of the extremities, where a technic similar to that used in conventional roentgenography can be employed. Xeroroentgenograms and conventional roentgenograms of the involved joint were taken of 100 patients admitted to the Albany Hospital (Albany, N. Y.) with pain or disability in an extremity. In some cases xeroroentgenograms, conventional roentgenograms, and microscopic slides were made of pathologic specimens.

The fine definition and contrast gradation is greater in the xeroroentgenogram than in the conventional roentgenogram in studies of both bone and soft tissue. Much of the contrast gradation is enhanced by a slight exaggeration of sharp margins due to a slight increase of powder on one side and a slight decrease on the other side of the boundary of the electrostatic charge on the xeroplate.

With the calcium carbonate powder now used, an image of low contrast is obtained. In such a xeroroentgenogram, unlike the conventional roentgenogram, both the radiodense and radiolucent portion of the image are shown. In a xeroroentgenogram of a knee, not only the fracture but also the margins of the quadriceps muscle, joint capsule, fat pads, and patellar tendon are visible. The injection of air into a joint further enhances the visualization of soft tissues. The margins of bones which are extremely osteoporotic or sclerotic are more clearly defined than in conventional roentgenograms. New-bone formation in the soft tissue is also often more apparent in the xeroroentgenogram.

Nine roentgenograms; 10 xeroroentgenograms; 1 photograph.

The Vascular Anatomy of Long Bones: A Radiological and Histological Study. Gunnar Tilling. Acta radiol. Suppl. 161, 1958. (University Hospital, Uppsala, Sweden)

Many recent workers have expressed the opinion that the epiphyseal plate constitutes a barrier separating the vascular systems of the diaphysis and epiphysis. The author has investigated this area in the growing stages of the long bone in calves and cows, and in some human material. A cannula was introduced into the nutrient arteries and veins of the diaphysis or epiphysis of the long bones, mainly the tibia; Urokon was used for contrast, and serial radiography with rapid film changing enabled the author to make interesting radiographs of the vascular system. Studies were also made with Micropaque injected into the femoral artery or vein, with subsequent examination of the bone before and after removal of the perichondrium or periosteum, and by intraosseous and intracartilaginous injection of Urokon.

The nutrient arteries and veins were shown to accompany each other, both in the central and peripheral circulation. The central vessels pass from the center of the diaphysis in both directions through the marrow cavity, extending to the epiphyseal plate, with an extensive metaphyseal ramification at each end. The peripheral vessels of the diaphyses arise from the periosteal network, and those of the epiphyses from the perichondrial network. The central and peripheral vessels were shown to anastomose.

The author showed that injection of the nutrient arteries in the epiphyses leads to filling of vessels in the diaphyses by way of vessels perforating the epiphyseal plate. This is demonstrated on a number of radiographs. The growth zones of the metaphyses are richly vascular, and their abundant blood supply is diaphyseal, metaphyseal, and epiphyseal in origin. Vascular channels of the epiphysis are shown to extend into the cartilage and not only to the ossification center. There are no valves in the veins of the long bones and retrograde angiography is not difficult. The veins are much larger than the arteries.

The author has proved that the epiphyseal plates do not constitute a barrier to the blood vessels during the growing period. The epiphyseal vessels penetrate them and thus there are vascular connections between the epiphysis and diaphysis from an early stage of growth. There are vascular connections across the apophyseal plates as well.

Angiograms demonstrate the vascular connections to the anterior tibial tubercle. Histological sections are shown of the vascular channels perforating the epiphyseal plates.

One hundred sixty-two roentgenograms; 12 photomicrographs; 3 diagrams.

W. A. DEARDORFF, M.D.
The Henry Ford Hospital

Roentgenological Symptoms in Habitual Dislocations of the Shoulder. V. Yu. Golyakhovsky and N. I. Seferova. Vestnik Rentgen. i. Radiol. **34:** 16–22, March-April 1959.

Habitual dislocations of the shoulder were studied in 25 patients, most of whom were or had been physical workers. Three posterior projections were used, with the part (1) supinated, (2) pronated, and (3) pronated and abducted. Various changes were revealed: peculiar deformity of the humeral head, "hatchet-head," defect of the postero-exterior part of the head, tear of a bone fragment of the anatomical neck, smoothing of the antero-inferior margin of the glenoid, metaplastic changes in the soft tissues, deforming arthrosis, tear of a fragment from the glenoid, and regional osteoporosis. It was concluded that some of these features are always present in habitual dislocation of the shoulder.

B. ABRAMSON, M.D., AND F. A. RIEBEL, M.D.
Columbus, Ohio

Osteoid Osteoma: A Fifteen-Year Follow-up of an Untreated Patient. Charles W. Vickers, David C. Pugh, and John C. Ivins. J. Bone & Joint Surg. **41-A:** 357–358, March 1959. (Mayo Clinic, Rochester, Minn.)

A 23-year-old man was seen in 1943 with roentgenographic findings typical of osteoid osteoma involving the upper right femur. The patient was unwilling to submit to surgery and was not seen again until 1958. The nidus appeared slightly less radiolucent on his second visit but otherwise the radiographic findings showed no change. The patient reported that his symptoms had gradually diminished in the fifteen-year period and he had become almost asymptomatic.

This case supplements other reported untreated cases in the literature which have shown osteoma to be a benign, self-limited process of long duration.

Two roentgenograms.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla

The Pathological Zones of Reconstruction in the Femoral Neck. V. I. Skotnikov and S. N. Lyando. Vestnik Rentgen. i. Radiol. **34:** 14–16, March-April 1959.

Zones of reconstruction (Looser's zones) are observed in all portions of the skeleton. The authors describe 2 cases with peculiar localizations in the femoral neck. In one the bilateral zones appeared as a result of repeated parachute descents and forced marches. In the other case static deformities of rickets were held to be causative in the formation of Looser's zones in one femoral neck and the lower extremities. Originally a fracture of the femoral neck was diagnosed in each case but disproved by clinical and roentgen evidence.

B. ABRAMSON, M.D., AND F. A. RIEBEL, M.D.
Columbus, Ohio

GYNECOLOGY AND OBSTETRICS

Cineradiographic Studies on the Fallopian Tubes in Rabbits. Lars Björk. Acta radiol. Suppl. 176, 1959. (University Hospital, Uppsala, Sweden)

A review of the literature revealed that the roentgen study of the fallopian tubes has been concerned primarily with anatomy and pathology. Little investigation of tube motility and function has been made, although the fact that the tubes are mobile has been known since 1708. Assessment of motility has become practicable with the development of image intensification technics and cinematography. For the study reported here a Philips 5-inch image intensifier was used with accompanying Arriflex 35-mm. camera.

The author's observations were made on rabbits. These animals have no regular estrus cycle, and ovulation occurs only after coitus. Thirty-two animals were utilized for preliminary studies; the final experimental series numbered 34. The abdomen was opened, a narrow polyethylene catheter was introduced into the ampullar part of the tube, and through this 0.05 to 0.1 ml. of 40 per cent Lipiodol was injected. After closure of the abdomen the rabbit was allowed to run about. Twenty-four hours later cineradiographic recordings (8 to 12 frames per second) were made over periods of thirty and sixty seconds. The following observations were made:

(1) Rabbits in anestrum (not in heat): Slow, rhythmical contractions (4–9 per minute); occasional peristalsis-like movement both to uterus and to ovary.

(2) Rabbits in estrus: More lively, stronger contractions (14–18 per minute) in both directions.

(3) Ovariectomized rabbits: No contractions.

(4) After copulation (doe in heat): Unchanged at first from (2): a slower rate eight hours post-coital.

The effects of various drugs were also evaluated.

Certain observations were at variance with those of other workers, notably that there was no difference between ampullary and isthmus motility and that, about the time of ovulation, the tubal motility was diminished.

Because of the similarity of the fallopian tubes in women and in the rabbit, the author suggests this means of clinical investigation. Approximately one minute of roentgen filming delivered 1,000 milliroentgens of radiation to the ovaries.

This supplement probably has little value for radiologists beyond its mention of another use of cineradiography. A contribution has been made to physiologists interested in the function of fallopian tubes.

Thirteen figures.

LT. COL. H. N. STURTEVANT, M.C.
Lackland AFB, Texas

The Pre-Natal Diagnosis of Thoracopagus Twins. H. P. Kent. J. Canad. A. Radiologists **10:** 4–7, March 1959. (Medical Arts Clinic, Regina, Sask., Canada)

The author reports what he believes is the first instance in which the diagnosis of thoracopagus twins was suggested radiologically before birth. From his own observation and a small group of cases undiagnosed prior to delivery he describes the roentgen signs:

"1. The most valuable, and evidently diagnostic feature is clearly the alignment of the foetal spines. In normal twins a flexed attitude of the foetal spines will usually be seen. In joined twins the foetal spines must always be abnormal, *i.e.*, either fully extended, or at least partially extended, since the joined bodies which face each other will prevent the assumption of a normal flexed attitude. . . . . Although follow-up films may show a change in the position of the twins within the uterus, the alignment of the foetal spines will remain abnormal.

"2. If the twins present head to head, breech to breech, the heads will lie at the same level, and remain at approximately the same level on follow-up radiographs, either facing each other, or obliquely set to each other, close together.

"3. The limbs will not be in their usual flexed position, but spreadeagled in various directions in the uterus.

"4. No bony junction will be apparent."

In an Addendum the author mentions 2 further cases in the recent literature in which a prenatal diagnosis of thorapagus twins was suggested radiologically (Roddie: Brit. M. J. **1:** 1163, 1957; Stigglebout: Brit. M. J. **2:** 727, 1958). He has overlooked the report of Gray and Wallace (Radiology **54:** 398, 1950), who cite 3 cases beside their own.

CARL J. PONISCHIL, M.D.
Cleveland Metropolitan General Hospital

THE GENITOURINARY SYSTEM

Roentgen Findings in Chronic Pyelonephritis: A Summarizing Study on the Diagnosis of Morphological and Functional Changes in Kidneys Affected with Pyelonephritis. R. Dejdar. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 196–220, February 1959. (In German) (Institut für Kreislaufforschung, Prague-Krč, Czechoslovakia)

The author has analyzed the x-ray findings in 153 cases of chronic pyelonephritis and correlated them with the clinical and pathological observations. The following x-ray changes have been noted and are listed in order of decreasing frequency.

1. Deformity of the upper collecting system: at first, mainly flattening of the papillae and rounding of the fornices; later, clubbing.
2. Diminished concentration of the contrast material.
3. Dilatation of the upper collecting system.
4. Changes of the width of the parenchyma of the kidney (widening or narrowing).
5. Hypotony or atony.
6. Changes in the size of the kidney shadow

(increased in infiltrative processes; decreased in cirrhotic processes).

7. Diminished density of the kidney shadow on the preliminary view.

8. Blurry or irregular outline of the kidney.

9. Delayed or indistinct excretion of contrast material.

10. Frequent associated findings are: urinary concretions, indistinct outline of the psoas muscle, strictures and other obstacles in the ureters, developmental anomalies.

The above changes are mostly asymmetrical. Only when at least three of the more common ones are present is a diagnosis of chronic pyelonephritis justified.

As to the differential diagnosis, tuberculosis is characterized by an irregular outline of the papillae and calyces, while in chronic pyelonephritis the outline is always smooth. Hydronephrosis and chronic pyelonephritis produce a similar picture but in the latter the calyces are dilated first and the kidney pelvis only in the late stages, while in hydronephrosis (mostly due to ascending infection), this order is reversed. In glomerulonephritis the changes are mostly symmetrical, in pyelonephritis asymmetrical. Cystic kidneys are easily differentiated if the cysts are large. If the cysts are small the distinction may have to be made on clinical grounds and may be difficult.

The earliest signs of chronic pyelonephritis are usually a rounding of the normally sharp fornices of the calyces and a flattening of the papillae.

Eighteen roentgenograms; 16 drawings; 3 graphs; 4 tables.

WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

Roentgenologic Diagnosis of Medullary Sponge Kidney. Nils Lindvall. Acta radiol. **51:** 193–206, March 1959. (Karolinska Sjukhuset, Stockholm, Sweden)

Medullary sponge kidney is the name given to kidneys showing multiple cysts and cavities in the medulla formed by dilatation of collecting tubules. Once considered rare, the condition is felt by the author to be commoner than is indicated by the few reports in the literature. He himself found 35 cases in a review of six years urographic studies.

The roentgen appearance is characteristic, showing cavities in one or more papillae. Typically they are seen to fill early in serial films. All but 2 of the author's cases showed calculi in varying numbers. Kidney enlargement was common. The condition is to be differentiated from tuberculosis, papillary necrosis, calyceal diverticula and cysts, tubular stasis and, when calculi are present, from nephrocalcinosis.

Nineteen reontgenograms; 3 photographs.

GEORGE L. SACKETT, M.D.
Cleveland, Ohio

Retrocaval Ureter. Report of a Case. P. Birger Nielsen. Acta radiol. **51:** 179–188, March 1959. (Roskilde Amts og Bys Sygehus, Roskilde, Denmark)

A 22-year-old male with a history of frequency experienced an attack of severe right flank pain followed by hematuria. On examination he was found to have delayed excretion and right hydronephrosis. On pyelography the catheter was seen to be medial to the lumbar pedicles and anterior to the vertebral column, while the pelvis and upper part of the ureter were dilated and S-shaped. Corrective surgery, with reanastomosis of the pelvis and ureter in antecaval position, was successful in decreasing dilatation.

The author discusses the embryology and reviews the literature on this anomaly. The following changes are listed as typical: (1) in long-standing cases, hydronephrosis and hydroureter in the upper course; (2) medial displacement of the ureter at the level of the third and fourth lumbar vertebrae; (3) a dorsal and medial course toward and close to the vertebral column, demonstrable in lateral and oblique views; (4) elongation and an S-shaped configuration of the pelvis and ureter when hydronephrosis is pronounced; (5) on urography, failure of the ureter to fill distal to the site where it is crossed by the inferior vena cava; (6) a spiral course. Venography, combined with excretory urography, retrograde pyelography, or the passage of a radiopaque catheter shows the exact course of the inferior vena cava encircled dorsally and medially by the ureter.

Five roentgenograms; 2 drawings; 1 table.

GEORGE L. SACKETT, M.D.
Cleveland, Ohio

Intravenous Urography with Renografin 60%. A Report of More Than 600 Cases. Louis M. Orr, James L. Campbell, and Miles W. Thomley. J.A.M.A. **169:** 1156–1158, March 14, 1959. (L. M. O., 1300 Kuhl Ave., Orlando, Fla.)

Intravenous urography was carried out in a total of 654 patients with Renografin 60 per cent as the contrast agent. Three hundred and ninety-four patients were males and 260 females. They ranged in age from seven to eighty-four years and in weight from 50 to 255 lb. Sixteen patients had a history of hay fever, asthma, or severe reaction to previously administered contrast media. At examination, 25 c. c. of the medium was given intravenously over a period of three minutes to every patient, with 3 exceptions; only 15 c.c. was given to 2 boys aged ten and thirteen years, respectively, and 10 c.c. to an adult patient who had had a severe reaction previously and was apprehensive about the possibility of a similar reaction to Renografin—which did not occur. Films were exposed at five, ten, and fifteen minutes after injection, with the patient erect at the final film. Good to excellent delineation of the renal collecting system was achieved in 636 of the 654 cases (97 per cent), while only a fair outline was obtained in the remaining 18. No patient in the present series experienced a severe reaction. Mild reactions, such as nausea, vomiting, a sensation of itching, flushing of the skin, urticaria, sneezing, and a choking sensation, were reported by 40 patients (6 per cent). On the basis of their experience, the authors consider Renografin 60 per cent a superior contrast agent for intravenous urography in the ambulant patient.

Four tables.

Value of Cavography in Diagnosis and Treatment of Retroperitoneal Metastases from Testicular Tumors. G. Notter and C. G. Helander. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 409–417, October 1958. (In German) (Karolinska Sjukhuset, Stockholm, Sweden)

Cavography, or venography of the inferior vena cava, was done in 28 patients with testicular tumors between 1955 and 1957. Under local anesthesia, the femoral vein is punctured 2 to 3 cm. below the inguinal

ligament, a catheter is inserted, and 25 c.c. of 30 per cent Urokon is injected at the rate of 7 to 10 c.c. per second. Bilateral injection is necessary for good results. Within two seconds following the injection two films are obtained, with a manual cassette changer, with the patient on his back. A second series of films is made, following a second injection, at a 45° angle.

Cavography is considered a good supplementary method for demonstration of metastases. In the present series, 33 cavographies on 28 patients, positive results were obtained in 6 of 20 seminomas and 8 of 13 carcinomas.

The authors conclude that positive cavography points to metastases, but a negative finding does not exclude small secondary lesions, especially in the region of the bifurcation of the aorta, the iliac vessels, or the left perirenal region.

Cavography is seldom positive in the absence of epigastric symptoms. In cases of seminoma without symptoms, therefore, cavography is not indicated. In carcinoma, it is indicated, but with positive findings the metastases are usually inoperable. Pelvic renography and urography, as well as isolated renography, may supplement cavography.

Ten roentgenograms; 1 table.

JULIUS HEYDEMANN, M.D.
Chicago, Ill.

The Incidence of Severe Reactions from Present Day Urographic Contrast Materials. Reed M. Nesbit. J. Urol. **81:** 486–489, March 1959. (University of Michigan Medical School, Ann Arbor, Mich.)

In answer to a recent questionnaire, members of the American Association of Genitourinary Surgeons reported their experience with the newer urographic media, Hypaque, Miokon, and Renografin. Severe nonfatal allergic or shock reactions occurred about once in 500 injections. There was a single death in the 144,500 injections reported. This occurred in a case in which 1.0 c.c. of the medium was introduced intravenously as a test. No reaction followed, and the final injection of Hypaque was given forty-five minutes later. Within five minutes the patient went into irreversible circulatory collapse. This death is difficult to explain; it is probably not to be accounted for on an allergic basis.

The majority of the group answering the questionnaire reported the use of intradermal or conjunctival tests for sensitivity but had little faith in them except as a protection against legal action.

There was general agreement that premedication with antihistamine compounds lessens the chance of severe allergic reactions and shock. The most satisfactory method apparently is intravenous injection of an antihistamine three to five minutes before injection of the iodinated compound. Some of the lesser reactions, such as nausea, vomiting, and arm pain, appear to be unaffected by such antihistamines as Benadryl and Chlortrimeton.

Currently under investigation at the University of Michigan is the compound Phenergan, an antihistamine drug with profound antiemetic properties: 12 mg. are given intravenously five minutes before the injection of the contrast material. Only 210 patients have been treated in this manner, but there appears to have been a significant decrease in nausea and vomiting. The sole disadvantage is the soporific effect which sometimes occurs.

Only by obtaining records from an enormous number of injections can the final value of antihistamine premedication be assessed.

Two tables. MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

TECHNIC

Lymphadenography in Clinical Practice. J. Prokopec and E. Kolihová. Fortschr. a. d. Geb. d. Röntgenstrahlen **89:** 417–424, October 1958. (In German) (Karls-Universität, Prague, Czechoslovakia)

The authors describe their experiences with direct percutaneous lymphadenography. Lipiodol F is the preferred medium (2 to 4 c.c.). It has less surface tension and fills the lymphatic vessels more rapidly than regular Lipiodol and shows less diffusion in the soft tissues than water-soluble contrast material. As an auxiliary procedure, an infusion of salt solution (300 to 500 c.c.) with 1 c.c. of adrenalin or with 6 mg. of hyaluronidase is used, to increase lymph flow. Dibenamine is given intravenously as a sympathomimetic.

With this method, the authors demonstrate superficial and deep lymph channels, with valves, diverticula, etc., in normal subjects, as well as in patients with neoplastic and other diseases. In the presence of lymphangitis carcinomatosa, the loss of diverticula and closed off lymph channels were noted.

Thirteen roentgenograms.

JULIAS HEYDEMANN, M.D.
Chicago, Ill.

Experimental Studies in Acute Retroperitoneal Carbon Dioxide Insufflation. B. Marvin Harvard, Robert R. White, and James F. Walsh, III. J. Urol. **81:** 481–485, March 1959. (West Haven VA Hospital, West Haven, Conn.)

The major complication of presacral perirenal pneumography is gas embolism. Carbon dioxide is quite safe but its use in this procedure has been limited by its rapid absorption rate which results in radiographs of poor diagnostic quality. It has become apparent that a large amount of gas must be introduced over a short period of time in order to produce satisfactory results.

The authors introduced carbon dioxide into the presacral space of mongrel dogs at approximately 200 c.c. per minute. The volumes ranged from 10 to 20 liters. In all instances the first 1,200 c.c. permitted prompt visualization of the retroperitoneal organs. Additional gas did not add or detract from the diagnostic quality of the films but did result in other interesting gross and radiologic changes such as massive subcutaneous emphysema and pneumothorax. Efforts to kill the animals were unsuccessful and all survived.

Five roentgenograms; 1 photomicrograph; 4 photographs; 1 electrocardiogram.

MAJ. MARTIN A. THOMAS, M.C.
MacDill AFB, Fla.

Does the Afterglow of Intensifying Screens Permit Lower Exposure Factors in Roentgenography? J. Meiler. Fortschr. a. d. Geb. d. Röntgenstrahlen **90:** 255–260, February 1959. (In German) (Siemens-Reiniger-Werke A.G., Erlangen, Germany)

It has been suggested that intensifying screens having a long and bright afterglow be used, in the

belief that the additional blackening of the film may permit shorter or lower exposure factors. Thus it was held that, when apparatus with half-wave rectification was used, the screens with heavy afterglow could make up for the loss of exposure during the suppressed half of the wave, or a short but intense x-ray impulse could, through afterglow, produce more blackening of the film than a longer but less intense x-ray beam.

The error in these assumptions rests in the belief that, with the beginning of the excitation of the x-ray current, the full intensity of illumination is instantaneously achieved. This is not a fact. It can be shown that with luminescent screens with a long afterglow the period of excitation until full illumination is reached is just as long as the period of afterglow, *i.e.*, what is gained in afterglow is lost in the period of excitation.

The author proved this by the following measuring procedure. An x-ray tube with a narrow cone was energized by a constant-potential current, and the beam was directed toward the luminescent material to be examined. Between the material and the cone was a revolving lead disk in which two opposite 90° sectors were cut out. The disk was rotated 50 times per second, and the x-ray beam going to the luminescent material was interrupted by the rotating disk at the ratio of 1 to 1. The duration of x-ray exposure is ten milliseconds as is also that of the interruption. The period of transition from light to dark is only 0.2 milliseconds. The light intensity was measured by means of a photomultiplier. A galvanometer measured the photo current exactly. First the value was determined with the disk stationary, the beam going through the empty sector of the disk. When the disk was rotated the value was cut exactly in half, irrespective of whether luminescent material with a long or a short afterglow was used. Thus it was proved that nothing was gained by employing intensifying screens with a long afterglow.

Oscillograms were also taken. The curves show that the afterglow amounts to no more than the delay in the excitation in the beginning.

Inasmuch as the afterglow may produce blurring of the image, the author believes that the ideal intensifying screen is the one with the least afterglow.

Six tracings. WILLIAM A. MARSHALL, M.D.
Chicago, Ill.

RADIOTHERAPY

Radiation Therapy in Cancer of the Larynx. A Review. Simeon T. Cantril. Am. J. Roentgenol. **81:** 456–474, March 1959. (From the Tumor Institute of the Swedish Hospital, Seattle 4, Wash.)

The author makes five major divisions in his presentation of radiation therapy in laryngeal cancer. These are (1) the early experiments, 1921–1932, (2) two decades of development and extension of the method, 1930–1950, (3) the classification of laryngeal cancer, (4) presentation of results, and (5) statement of conclusions.

It was Coutard who seriously began the treatment of laryngeal cancer with x-radiation. In the period 1921–1922 he treated 32 cases. In his first report he stated that cancer of the larynx could be successfully treated without lethal radiation injury and with preservation of respiration and phonation; this was done by protraction of a dose which did not exceed but bordered on the limits of normal tissue tolerance. He noted, also, the variability of response between infiltrative and non-infiltrative epidermoid cancer, and stressed the necessity for homogeneous irradiation, particularly when high dose levels were required in infiltrating and less radiosensitive cancers. Coutard was among the first to use the patients' response to serve as a guide for the administration of therapy.

During this initial period the following observations were made and recorded: (1) the effect of vasculoconnective tissue reactions on radiosensitivity of cancer cells, (2) the daily and total dose as these influenced cancerocidal effects, (3) the distribution of dose in time, and (4) the early and late complications as guides to irradiation.

In the two decades of development and extension, 1930 to 1950, the method of Coutard spread widely throughout Europe and overflowed into the Americas. During this period certain contributions were made which have strengthened our present concept of the overall management of cancer of the larynx. These had to do with the pathologic anatomy of laryngeal cancer, technical developments which have added to the ease and efficiency of irradiation, a greater appreciation of the time factor in the achievement of a higher dose without late serious injury, and last, but not least, a fuller collaboration with surgeons in the total care of the patient. Progressive improvement in the results of treatment were not seen because of lack of experience with the method.

A topographic classification of laryngeal cancer seems preferable to the anatomic or clinical one. Apart from minor differences there has developed a common language describing supraglottic, glottic, and subglottic types. A detailed classification recommended by the Committee on Tumor Classification of the 1953 International Congress of Radiology is appended.

It is concluded that improvement in treatment of laryngeal cancer by irradiation has been demonstrated. The results are equal to those of surgery in several comparable series. The author is of the opinion that with a wider use of higher energy there will be an improvement in the outlook for more advanced cases. Other factors contributing to better results are noted. A plea is made for the training of a larger number of competent radiotherapists. The opinion that radiation is as effective as surgery in the treatment of laryngeal cancer in comparable cases is substantiated by data contained in 6 tables included in the paper. Throughout it is stressed that surgery and irradiation are not competitive methods of therapy but complementary when properly used.

H. C. JONES, M.D.
Grand Rapids, Mich.

Treatment of Cancer of the Paranasal Sinuses and Nasal Fossa. James W. Hendrick. Arch. Otolaryng. **68:** 604–616, November 1958. (426 East 10th St., Tuscaloosa, Ala.)

The greatest incidence of cancer of the paranasal sinuses and nasal fossa is in persons between the ages of fifty and seventy years. In the series of 76 cases

reported by the author, the youngest patient was a 2-year-old girl with fibromyxosarcoma of the left antrum. Eight tumors involved the nasal cavity and 68, the paranasal sinuses (in 64 patients, the maxillary sinus). No definite etiological factors were apparent; chronic sinusitis, nasal infection, allergic rhinitis, and nasal polyps were frequently observed. Three patients with antral cancer, twenty-eight, forty, and forty-four years of age, respectively, had histories of having had nasal polyps removed at frequent intervals over a period of ten to fifteen years. There is considerable variation in the normal course and duration of malignant tumors of the paranasal sinuses and nasal fossa. This variation is due to several factors: (1) the histologic type of tumor, (2) its grade, and (3) the age and general physical condition of the patient. The primary method of extension of these tumors is by direct invasion of surrounding tissue, and, to a less degree, by the lymphatics and blood stream.

The first definite roentgen evidence of malignant tumor is bone destruction produced by invasion of the sinus wall. As the disease progresses and the sinus wall is completely destroyed, there is a sharp contrast between normal and involved bone. Because there is natural overlapping of bone shadows in this anatomical area, an early malignant growth may not be detected unless great care is exercised by the radiologist. Of the 68 cases of malignant tumor of the paranasal sinuses, 50 showed destruction of one or more sinus walls on roentgen examination. Tomography is helpful in these cases. Diagnosis must be established by histologic study of representative tumor tissue removed either through a Caldwell-Luc incision or by aspiration biopsy.

When the diagnosis of cancer of the paranasal sinuses is made early, the treatment of choice is radical surgery with preoperative and/or postoperative irradiation. The irradiation is delivered through three ports, varying in size from 4 to 6 cm. If the orbit or ethmoid and/or sphenoid cells are involved, or if there is extension of the tumor into the pterygoid fossa, a fourth and, if necessary, a fifth port may be used, one through the zygoma just above the lateral port and one straight through the orbit from the front. The dose varies from 2,000 to 3,000 r through each port, given in daily doses of 300 r. Epithelitis, desquamation, and occasionally blistering result, but these complications disappear after a period of four to six weeks.

Conservative surgery does not permit removal of sufficient tissue to effect a cure for patients with cancer of the paranasal sinuses. It is necessary to resect the superior maxilla and frequently exenterate the orbital contents. The latter procedure was done in 30 of the 44 patients in the present series who received radiotherapy followed by radical surgery. Complications resulting from the loss of one eye, however, are totally outweighed by the increased protection afforded by the more extensive operation. Contraindications to operative treatment are (1) invasion of the base of the skull; (2) bilateral involvement demonstrated roentgenologically in cancer of the frontal sinuses, ethmoid and sphenoid cells, and those cases in which the medial wall of the antrum is involved and the lesion has extended to the opposite side; (3) involvement of the wall of the nasopharynx; (4) metastases below the clavicle; (5) advanced age with associated debility. Only 2 patients in this group had metastases to the regional lymph nodes when first observed; these patients had radical neck dissection in addition to resection of the superior maxilla, and 1 had exenteration of the orbit. Any area which may contain residual cancer is treated with radium needles or tubes in rubber cots, for a total dose calculated to be 6,000 to 10,000 r at 1 cm. depth.

When the cancer originates in the ethmoid or sphenoid cells, surgical exploration is carried out before irradiation. All tumor-bearing tissue is electrocoagulated, curetted, and recoagulated until normal-appearing tissue remains. Radium, in the form of plaques, is applied for a total dose of 6,000 to 10,000 r. The 2 patients in the present series who had cancer arising in the sphenoid or ethmoid cells died from intracranial invasion within two years.

Small squamous-cell carcinomas of the mucocutaneous junction of the columella are treated with roentgen irradiation by the same technic as for squamous-cell carcinoma of the skin, or radium tubes may be placed directly against the growth with a small lead plate between the tubes and the ala of the nose to protect it. Radiosensitive tumors of the nasal fossa are treated with x-ray therapy. Daily treatments are administered in varying amounts, depending on the size of the field, for a total dose of 4,000 to 5,000 r. If necessary, two or three ports are used, with the uninvolved surrounding areas protected by a sheet of lead 0.25 cm. thick. Some extensive, well differentiated carcinomas of the nasal fossa which are not considered to be radiosensitive are first irradiated, using 3,000 to 4,000 r, delivered over a period of three to four weeks. After six weeks, any remaining tumor is removed surgically.

In 40 patients with cancer of the paranasal sinuses and in 4 with cancer of the nasal fossa, the disease was advanced when diagnosis was made. Irradiation *only* was used in 20 patients with antral cancer because of the presence of one or more contraindications to surgery. Ten patients have been followed from four to seven years: 7 died from recurrent cancer; 1 died from an unrelated disease; 2 are living and are clinically free of cancer but have complications resulting from radiotherapy. For the other 10 patients, who have been followed from a few months to three years, no statistical data are available.

Preoperative irradiation was employed in all patients with operable cancer of the paranasal sinuses. Forty-four patients had irradiation followed by radical surgery. Twenty-one of these patients have been followed from four to seven years; 1 has been lost to follow-up; 2 have died from unrelated disease; 2 have died from recurrent cancer, and 19 are living and have been clinically free of their disease from four to seven years. The other 23 patients have been followed less than four years.

Four of the 8 patients with cancer of the nasal fossa received radiotherapy; all died within one to three years after they were first observed. The other 4 were treated with a lateral rhinotomy incision with thorough removal of the tumor by electrosurgery; these have been followed from four to seven years and are clinically free of their disease.

Two patients refused all therapy, and in 2, disease was too advanced to warrant treatment.

Eight figures; 4 tables.

Glomus Tumors, Their Response to Irradiation. Robert J. Reeves and Owen W. Doyle. Am. J. Roentgenol. **81:** 475–478, March 1959. (Duke University, Durham, N. C.)

Glomus tumors are generally found in the adventitia of the dome of the jugular bulb, immediately below the bony floor of the middle ear and near the ramus tympanicus of the glossopharyngeal nerve. In microscopic appearance they resemble the carotid body.

The tumors spread slowly and metastasize quite rarely. Most of them are considered benign. Unless tumor cells can be demonstrated invading the tumor capsule or vessel walls, it is difficult, if not impossible, to make a diagnosis of malignancy. Possibly not more than 15 per cent of the reported cases were malignant.

The authors here present 4 cases of glomus tumors involving the middle ear, with a summary of the roentgen therapy which was given. The patients entered with complaints of deafness, dizziness, and pain related to the ear involved. Biopsy was attempted in each instance but complete removal of the tumor was difficult because of the location. Roentgen therapy was given following surgery, for a tumor dose of approximately 3,500 r. All of the patients are said to be doing well after periods ranging from two months to several years.

The fact that most of these tumors are questionably malignant makes the evaluation of roentgen therapy very difficult.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

Hodgkin's Disease of the Oral Cavity. George Meyer, Bernard Roswit, and Sol M. Unger. Am. J. Roentgenol. **81:** 430–432, March 1959. (VA Hospital, Bronx 68, N. Y.)

Lymphoma is rare in the oral cavity. Small-cell lymphosarcoma of the tonsil and base of the tongue is occasionally seen, and a reticulum-cell sarcoma may appear following extraction of a molar tooth. The authors report what appears to be the first case of Hodgkin's disease of the mucous membrane of the retromolar area. The disease was controlled locally at this site but dissemination occurred after a three-year period.

Four roentgenograms; 1 photograph.

J. A. GUNN, M.D.
Grand Rapids, Mich.

The Rapid Palliative Treatment of Breast Carcinoma. A Preliminary Report. Donald Q. Cochran, Sumner Holtz, and William E. Powers. Am. J. Roentgenol. **81:** 479–484, March 1959. (Washington University School of Medicine, St. Louis, Mo.)

The relatively long time required for conventional therapy and the morbidity resulting from its use have been the main arguments against palliative radiation therapy for advanced carcinoma of the breast.

The authors describe a two- or four-day treatment technic with a betatron producing 22.5-Mev roentgen rays, in which the breast tumor and lymph nodes receive a tumor dose varying from 1,250 to 2,500 r. Six of the seven patients who have lived sufficiently long for follow-up have had excellent local control of the tumor with minimal skin changes and no other significant complications.

The authors have been sufficiently encouraged by the result to date to use this method on less advanced breast carcinomas.

Seven photographs.

J. A. GUNN, M.D.
Grand Rapids, Mich.

Postoperative Irradiation of 86 Cases of Carcinoma of the Cervix. Leonard M. Liegner, Marshall Olson, and James J. Nickson. Surg., Gynec. & Obst. **108:** 313–320, March 1959. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

The authors report a series of 86 patients with carcinoma of the cervix who received primary surgical treatment at the Memorial Center for Cancer and Allied Diseases in New York, with postoperative radiation therapy. None had been given preoperative irradiation.

The operative procedures employed were: hysterectomy and node dissection, excision of the cervical stump and node dissection, exenteration (anterior, posterior, or total), exploratory laparotomy, Schauta hysterectomy, Wertheim procedure, and simple cervical excision. The more favorable cases according to the League of Nations staging were treated, in most cases, by radical hysterectomy and node dissection. The more advanced cases received either radical surgery or exploratory laparotomy.

The series is divided into pre-treatment categories. Category I consisted of 15 cases in which the primary disease and involved nodes were completely excised, as established by absence of gross disease within the pelvis postoperatively and histologic evidence that the margins of excision showed no tumor cells. Category II consisted of 27 postoperative recurrences. Category III consisted of 24 cases with postoperative persistent tumor. This category was further subdivided into Group IIIA, which contained 11 patients in whom carcinoma was present in the pelvis or nodes as proved by biopsy or by histological evidence of tumor at the margins of resection; Subgroup IIIB consisting of 13 patients in whom the surgeon believed tumor was left behind or the pathologist saw neoplastic cells near the margins of resection. Category IV included 20 cases in which exploratory laparotomy had shown the tumor to be inoperable either because of its extent or extrapelvic node involvement.

The radiation therapy employed was mainly from a 1-Mev apparatus. Pelvic or abdominopelvic parallel opposing (inverted T) fields were employed. A tissue dose of 4,000 to 4,500 r was delivered to most patients in increments of 1,000 r per week.

Eight patients in Category I survived longer than eighteen months. Four of these patients were still alive at the time of the report and free of carcinoma. Nine patients in Category II survived more than eighteen months; 4 of these were still living. No long-term survivals were found in Category IIIA. In Category IIIB 8 patients survived longer than eighteen months, 3 of these were still alive with no evidence of carcinoma. Of 20 patients in Category IV only 1 survived more than 18 months but died three years post-therapy. The survival periods for the patients still alive at the time of this report ranged from thirty-two to eighty-four months following irradiation.

The authors feel that postoperative irradiation in the presence of proved recurrent disease can bring five-year arrests and considerable palliation, with

prolongation of life, to a group of patients in whom further surgical treatment is of no value.

Three figures; 9 tables. ROBERT JACOBS, M.D.
University of Pennsylvania

High Pressure Oxygen and Radiation Therapy. Cyril Sanger Am. J. Roentgenol. **81:** 498–503, March 1959. (Hartford Hospital, Hartford 15, Conn.)

There has been considerable interest during the past few years in the relationship between the radiosensitivity of cells and the oxygen concentration in their environment. Gray and his colleagues have shown that suboxygenated cells are relatively insensitive to radiation. It has been shown that such cells are probably present in human tumors. If the oxygen tension is increased, the sensitivity of these cells to radiation may be restored without greatly raising that of normal tissue. This may be achieved in man by the inhalation of oxygen under high pressure in a pressure chamber.

The author describes the technic as well as the pressure chamber apparatus used at St. Thomas Hospital London, for this purpose. The object is not merely to potentiate the effect of radiation on all cells indiscriminately, but to restore to a few tumor cells their differential sensitivity as compared with normal tissue. It is upon this differential that the whole concept of radiation therapy is based and it is this differential which is destroyed by hypoxia.

An earlier, preliminary report on the first 35 cases treated is cited (Churchill-Davidson *et al.*: Brit. J. Radiol. **30:** 406, 1957. Abst. in Radiology **70:** 908, 1958). Though valid statistical evidence is not yet available, the initial response was most encouraging. In most cases it greatly exceeded that which might be expected from conventional methods, and this was particularly so in 11 cases of carcinoma of the tongue, tonsil, and pharynx and in 2 chondrosarcomas and 1 myxosarcoma.

Other methods of approach to the problem are considered but the conclusion reached is that the inhalation of oxygen under high pressure is likely to remain the most effective technic in the light of present knowledge.

Two photographs; 5 graphs.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

The Effect of Mitotic Suppression and Recovery after Irradiation on Time-Dose Relationships and the Application of This Effect to Clinical Radiation Therapy. Paul W. Scanlon. Am. J. Roentgenol. **81:** 433–455, March 1959. (Mayo Clinic, Rochester, Minn.)

The author has reviewed considerable experimental and clinical material in an effort to enhance the knowledge of radiobiological effects. It has been demonstrated that susceptibility to damage by radiation is greatest during the mitotic phase of the life span of any cell. It, therefore, follows that for any given amount of radiation the effect will be greatest following administration during the period of highest mitotic activity.

An important direct effect of radiation is a temporary suppression of mitotic activity, the duration of and magnitude of the suppression depending upon the amount of the initial radiation and the type of tissue being irradiated. Recovery of the mitotic process is more rapid in undifferentiated tissue.

Subsequent radiation during the period of suppressed mitotic activity is relatively ineffective, the effect on malignant cells in various stages differing not at all from that on surrounding normal tissue. Furthermore, continued radiation during this period further serves to keep mitotic activity in abeyance and prevents its resumption with its attendant radiosensitivity. These undesirable effects may be countered by the use of broken dose or interrupted type radiation technics.

Evidence is given to support the contention that, if therapy is interrupted long enough for tissue recovery and resumption of mitotic activity, the ultimate radiation effect is enhanced, with greater cellular degeneration being produced by relatively smaller amounts of radiation.

A time-analysis of 46 cases of carcinoma of the palatine tonsil, 88 cases of carcinoma of the nasopharynx, and 43 cases of carcinoma of the anus was carried out. The effectiveness of broken-dose or interrupted therapy, in terms of five-year survival, was 3 or 4 to 1 over conventional daily fractional radiation therapy. Clinical stage of the disease, pathological subgrouping, and total dose received could not account for the superiority of the results with the interrupted technic.

Potential and actual dangers are present with this technic, however, as the increase in biological activity involves both the neoplasm and the surrounding normal tissue. It would appear that, until more is known of the differential recovery time between malignant and normal tissue, and the recovery time from initial radiation doses of various amounts, radiation morbidity will accompany broken-dose or interrupted therapy.

Six figures; 9 tables. J. A. GUNN, M.D.
Grand Rapids, Mich.

The Modification of the Radiation Response. J. Robert Andrews and Stanley E. Sneider. Am. J. Roentgenol. **81:** 485–497, March 1959. (National Cancer Institute, Bethesda, Md.)

The authors state that there is, at present, no generally acceptable evidence that any physical, chemical, or biologic agent acting in combination with ionizing radiations, results in synergistic cancericidal effects in the treatment of human cancer. The purpose of this paper is to attempt to enunciate general principles for the study of the modification of the radiation response.

The authors list eight steps of radiation response: Step No. 1 is the energy transfer; Step No. 2, ionization and excitation; Step No. 3, decomposition of water; Step No. 4, chemical reactions; Step No. 5, biochemical reactions; Step No. 6, biologic injury; Step No. 7, recovery or replacement; necrosis, carcinogenesis, or mutagenesis; Step No. 8, the end effect.

Each of these steps is discussed in considerable detail and their significance can be appraised only by a study of the original paper.

The authors mention, in an Addendum, that a strong case has been made for the use of a synthetic compound, Synkavit, as a potentiating agent in the radiation therapy of carcinoma of the lung. This was reported by J. S. Mitchell in 1957 (Acta Unio internat. contra cancrum **13:** 450, 1957) and, from the summary of Mitchell's cases, it does appear that the use of roentgen therapy plus Synkavit prolongs the life of patients with pulmonary carcinoma. The au-

thors feel, however, that further study with this drug should be done before definite conclusions can be drawn.

Mention is also made of the use of radiation therapy with oxygen under pressures of three to four atmospheres. From preliminary reports it appears that there may be some advantage to using this type of treatment.

Two graphs; 9 tables.

J. P. CHAMPION, M.D.
Grand Rapids, Mich.

RADIOISOTOPES

Simple Physical Concepts in I^{131} Thyroid Uptake and Differential Studies. Marion F. Magalotti and Irvin F. Hummon. Am. J. Roentgenol. **81:** 43–46, January 1959. (Cook County Hospital, Chicago 12, Ill.)

There are certain fundamentals with which one must be familiar in performing a satisfactory I^{131} uptake and differential study.

I. *Physical Features of I^{131} Thyroid Uptake.*

1. Detector. A scintillation tube is much more sensitive than the Geiger-Müller tube and, for that reason, is preferable. As a result of the greater sensitivity of the scintillation tube, the operator has to be alert to interfering radiation from radioactive sources in the vicinity.

2. Collimator. The collimator is essential to reduce the "visual field" of the crystal. A poorly collimated detector would read too large an area. On the other hand, a strongly collimated detector would not be "seeing" the entire desired area to be counted. A method of checking the isosensitivity of a collimated detector, at the distance being used in uptake studies, is described.

3. Distance. The isosensitivity study of the collimator will serve as a guide in choosing the proper distance from the detector to the thyroid. Such a distance is one that will allow the collimated detector to "see" the thyroid satisfactorily and also permit a sufficiently high count—approximately fifty times the background.

4. Filter. If a discriminator is not used, soft, scattered radiation reaching the crystal can be minimized by using an "A" filter of 1/16 inch lead at the aperture of the collimator.

5. Recorder. A rate meter or scaler is satisfactory for recording. The decimal scaler is used more frequently because of its dependability and ease of reading.

6. Reference Source. A gamma-emitting source with a rather long half-life should be used to check on the proper operation and constancy of the detector.

7. Body Background. The lower thigh has a diameter similar to the neck, and a thigh count may be used to estimate body background.

8. Phantom. A cylinder of Lucite is used to count the tracer to simulate the neck and produce a similar spectrum.

II. *Physical Features of Differential Studies.*

A differential study consists of a comparison of arbitrary counts, usually taken at identical points on each side. By this method, the relative function of a thyroid nodule or metastatic site may be determined.

Three diagrams; 1 table.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

The Effect of Disease and Drugs on the Twenty-Four Hour I^{131} Thyroid Uptake. Marion F. Magalotti, Irvin F. Hummon, and Ernst Hierschbiel. Am. J. Roentgenol. **81:** 47–64, January 1959. (Cook County Hospital, Chicago 12, Ill.)

While the performance of a twenty-four-hour radioiodine (I^{131}) thyroid uptake study is technically simple, the interpretation of the results is a medical task that is frequently not easy. The authors have listed and discussed problems in interpretation encountered in over 6,000 I^{131} tracer studies. They present here the fundamental concepts of I^{131} thyroid uptake, as obtained from their experience and a review of the literature, to afford a convenient working reference. The following outline is indicative of the scope of their paper.

A. The Twenty-Four-Hour I^{131} Uptake in Certain Thyroid Conditions: (1) Euthyroidism. The twenty-four-hour I^{131} thyroid uptake in euthyroidism is generally accepted to be between 15 and 40 per cent. Values between 10 and 15 per cent and between 40 and 50 per cent may, however, be found in euthyroid persons.

(2) Hyperthyroidism. Uptakes of over 50 per cent are compatible with, but do not necessarily establish, a diagnosis of hyperthyroidism.

(3) Hypothyroidism. Uptakes between 5 and 15 per cent are compatible with hypothyroidism. When a low value is found which does not coincide with the clinical picture, other investigation is indicated to elicit interfering factors.

(4) Myxedema. Myxedema results from prolonged lack of thyroid hormone. I^{131} uptakes range from 0 to 5 per cent.

(5) Iodine Deficiency Goiters. These goiters may take up less iodine per gram but, because of their large size, the total uptake may be equal to that of a normal gland. Scanning shows the I^{131} uptake to be uneven.

(6) Diffuse Exophthalmic Goiter or Graves' Disease. Uptake values of 50 per cent or more may be found. There is no correlation between the severity of the disease and the height of the I^{131} thyroid uptake.

(7) Toxic Nodular Goiter. The I^{131} uptake is in the hyperthyroid range. Usually the nodule has a count several times that of the rest of the gland.

(8) Struma Lymphomatosa, Hashimoto's Disease. Uptake values between 5 and 95 per cent have been reported, but generally the figure is in the normal or low normal range.

(9) Acute Thyroiditis. Extremely low uptake values are observed. The I^{131} uptake gradually returns to normal after recovery.

(10) Invasive Fibrous Thyroiditis, Riedel's Struma. There is a replacement of the thyroid parenchyma by dense fibrous scar tissue. Depending on the stage of the disease, the I^{131} uptake may be normal or depressed.

(11) Granulomatous Thyroiditis, de Quervain's Thyroiditis. The I^{131} uptake is usually zero or markedly depressed, although occasionally normal values are found.

(12) Irradiated Thyroid. Irradiation of the thyroid by roentgen rays or therapeutic I^{131} will reduce the I^{131} uptake. The amount of reduction depends on the dosage and the time factors.

(13) Postsurgery Thyroid. I^{131} uptake is temporarily depressed after partial thyroidectomy or a simple exploratory operation.

(14) Cretinism. An increase in I^{131} uptake is seen, rather than the decreased activity which one might expect.

B. The Twenty-Four-Hour I^{131} Thyroid Uptake in Neoplastic Goiters: (1) Adenoma. The thyroid adenomas usually do not produce significant amounts of hormone. When hyperthyroidism is present with adenomas, it is usually due to hyperplasia of surrounding thyroid tissue.

(2) Carcinoma. Carcinoma has never been demonstrated to concentrate I^{131} as avidly as normal thyroid tissue. The finding of a low I^{131} uptake is merely consistent with neoplasm and will depend in part on how much normal thyroid tissue has been replaced by tumor.

C. The Twenty-Four-Hour I^{131} Thyroid Uptake in Certain Systemic Conditions and Extrathyroid Diseases: (1) Childhood. The commonly used ranges for adults apply also to children.

(2) Senescence. There is no convincing proof that secretion of thyroid hormone decreases with advancing age.

(3) Mongolism. The twenty-four-hour I^{131} thyroid uptake is in the normal or low normal group.

(4) Pituitary Disease. The twenty-four-hour I^{131} thyroid uptake is in the normal range in most patients with pituitary tumors.

(5) Addison's Disease. Usually the I^{131} uptake will be normal.

(6) Liver Disease. An increased uptake of I^{131} has been observed frequently in patients with liver disease, but there is no evidence of increased production of thyroid hormone either by clinical or laboratory methods of examination.

(7) Renal Disease. The twenty-four-hour I^{131} thyroid uptake is not affected by renal disease.

(8) Congestive Heart Failure. The twenty-four-hour I^{131} uptake remains normal.

(9) Pancreatic Insufficiency. The I^{131} uptake is low, not over 3 per cent.

(10) Iodine Restricted Diet. After a prolonged iodine deficient diet, the I^{131} thyroid uptake is likely to be high.

(11) Alcoholism. Alcoholics often show an elevated I^{131} thyroid uptake without clinical evidence of hyperthyroidism.

(12) Pregnancy and Menstruation. During the last ten weeks of pregnancy, thyroid I^{131} uptakes are increased by approximately 15 per cent. The twenty-four-hour uptake is not altered by the menstrual cycle.

(13) Anorexia Nervosa. I^{131} thyroid uptake is normal.

(14) Myotonic Dystrophy. I^{131} thyroid uptake studies may be normal or below normal.

(15) Malignant Melanoma. Melanoma does not alter the twenty-four-hour I^{131} thyroid uptake.

(16) Leukemia. No alteration of the I^{131} thyroid uptake occurs, although the basal metabolic rate may be elevated.

(17) Acute Bleeding. During active bleeding, the I^{131} thyroid uptake values are between 0 and 25 per cent.

D. Chemicals and Drugs Influencing the Twenty-Four-Hour I^{131} Thyroid Uptake: Most iodine-containing medication will invalidate the study for a period of time. Cough syrups, skin ointments, and substances used in dental procedures may contain sufficient iodine to interfere with I^{131} thyroid uptake tests. Iodine-containing dyes used as contrast media may depress the I^{131} thyroid uptake.

(1) Antithyroid Drugs. The twenty-four-hour I^{131} thyroid uptake is depressed during the administration of thiourea derivatives in euthyroid as well as hyperthyroid patients.

(2) Thyroid Medication. The ingestion of thyroid substance decreases the function of the thyroid gland.

(3) Thyroid Stimulating Hormone (TSH). TSH increases I^{131} uptake by the thyroid gland.

(4) Sulfonamides. Sulfonamides belong to the aminobenzene group, which acts similarly to the thiourea derivatives.

(5) Thiocyanate, Perchlorate, Nitrate. The I^{131} thyroid uptake is depressed.

(6) Gonadal Hormones. No significant influence has been found.

(7) Adrenal Cortical Steroids and Stress. The twenty-four-hour I^{131} thyroid uptake is markedly depressed.

(8) Resorcinol. The action of resorcinol is similar to that of thiourea derivatives.

(9) Cobalt Medication. Depressed I^{131} thyroid uptakes have been observed with cobalt medication.

(10) Para-aminosalicylic Acid (PAS) and isoniazid. These drugs may exert an antithyroid effect.

(11) Tranquilizing Agents. The I^{131} uptake is elevated, without clinical signs of hyperthyroidism.

(12) Antihistamines. The drugs in this group interfere with the thyroid uptake of iodine.

(13) Food. No effect is exerted on the twenty-four-hour I^{131} thyroid uptake by the usual quantity of foods normally ingested.

(14) Mercurials. Mercurials may depress the I^{131} thyroid uptake.

(15) Antibiotics. Antibiotics exert no remarkable effect upon the I^{131} thyroid uptake.

Five tables.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Evaluation of Routine Scintiscanning of Nontoxic Thyroid Nodules. I. The Preoperative Diagnosis of Thyroid Carcinoma. H. P. Groesbeck. Cancer 12: 1–5, January-February 1959. (3503 Fourth Ave., San Diego, Calif.)

During a four-year period, scintigrams were performed on 527 patients with nontoxic thyroid nodules. Isotopic function could be correlated with the histologic findings in 253 of these patients treated surgically. Included were 39 cases of cancer, of which 23 were newly discovered. The other 16 had been diagnosed previously and were excluded from analysis.

Nodules were classed as hyperfunctioning, functioning, or nonfunctioning. All hypofunctioning nodules were included in this last group. There were 13 hyperfunctioning nodules, none of which was associated with cancer. Of 141 nodules classified as nonfunction-

ing, 20 proved to be malignant. The other 3 cancers were found in the group of 83 functioning nodules.

These last 3 cases were all clinically diagnosed as carcinoma preoperatively, 2 showing cervical metastases. The incidence of subclinical cancer in functioning nodules would thus appear to be extremely low. It must, however, be emphasized that cancer can, and does, occur in patients with hyperthyroidism. A twenty-four-hour I^{131} uptake exceeding 35 per cent was recorded in 8 of the 39 carcinomas in this series. However, the cancerous nodules were classed as nonfunctioning in 7, and functioning in 1 case.

Whereas previously undiagnosed carcinoma was proved to be present in 9.7 per cent of the patients in the entire series, carcinoma was found to be virtually four times more frequent in those patients with nodules classified as nonfunctioning. This relationship held true whether the functioning nodules were solitary or multiple.

Although evidence indicates that the overwhelming majority of carcinomas have less than normal function in the presence of a functioning normal gland, this does not mean that all nonfunctioning nodules must be surgically removed. Typical quiescent deficiency goiters will exhibit areas of impaired function, and nonfunctioning nodules have been seen with struma lymphomatosa.

The author concludes that routine scintiscanning of thyroid nodules is an important laboratory study, but it is not a substitute for careful clinical evaluation. If the patient's history, sex, and age and the nodule's consistency, for example, suggest the possibility of carcinoma, surgery for diagnosis must be advised.

Three scintigrams; 4 tables.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

Evaluation of Routine Scintiscanning of Nontoxic Thyroid Nodules. II. The Postoperative Management of Thyroid Carcinoma. H. P. Groesbeck. Cancer **12:** 6–9, January-February 1959. (3503 Fourth Ave., San Diego, Calif.)

The author discusses the value of postoperative scintiscanning in the routine management of thyroid carcinoma, on the basis of 20 cases. The majority of the patients received one or more doses (10 mg. each) of thyroid-stimulating hormone (TSH) prior to the test dose (0.25 to 2.0 mc) of I^{131}.

Thyrograms demonstrated that a truly total thyroidectomy can be accomplished, contrary to the growing feeling in some isotope centers that performance of such surgery is virtually impossible. Of 15 patients who had purportedly total thyroidectomies, 6 showed complete absence of functioning thyroid tissue, while 9 showed some residual activity in the thyroid area.

The clinical circumstances in which postoperative scintiscanning is most commonly applied can be divided as follows:

(1) Routine postoperative survey, particularly after total thyroidectomy, to assay the thoroughness of the surgery and delineate any residual thyroid tissue or functioning metastases.

(2) Survey of patients with operable recurrent or metastatic carcinoma prior to reoperation, to furnish accurate localization of all foci of functioning tissue.

(3) Evaluation of post-treatment results after I^{131} therapy for inoperable recurrences or metastases.

Three case reports are included.

Eight scintigrams.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

The Use of the Scanograph in the Diagnosis of Masses at the Base of the Tongue. James A. Harrill, Joseph E. Whitley, and I. Meschan. Ann. Otol., Rhin. & Laryng. **68:** 108–114, March 1959. (Bowman Gray School of Medicine, Winston-Salem, N. C.)

The differential diagnosis of masses presenting at the base of the tongue in infants and children most often lies between a thyroglossal duct cyst, accessory thyroid tissue, and an ectopic thyroid gland. Preoperative differentiation of these conditions is critical in the consideration of their surgical treatment. Biopsy is often hazardous, as bleeding in this location is sometimes difficult to control.

The affinity of normal thyroid tissue for iodine in a normal or ectopic location makes possible its differentiation and delineation by radioisotopic technic. Scanograms of the oral pharynx and neck twenty-four hours following oral administration of a tracer dose of I^{131} are employed in such cases prior to consideration of biopsy.

Scanography lacks the hazards of surgical biopsy and gives accessory information as to the entire distribution of thyroidal tissue. If the total thyroid gland is represented by the mass, surgical biopsy is not necessary and is probably contraindicated.

Two cases are reported.

Four scanograms. STEPHEN N. TAGER, M.D.
Evansville, Ind.

The Diagnostic and Therapeutic Value of Thyrotropic Hormone and Heavy Dosage Scintigrams for the Demonstration of Thyroid Cancer Metastases. Boris Catz, Donald Petit, and Paul Starr. Am. J. M. Sc. **237:** 158–164, February 1959. (University of Southern California School of Medicine, Los Angeles, Calif.)

The authors' program of treatment of cancer of the thyroid, ranging over a period of six years, showed that 78 per cent of their cases with metastases collected I^{131}. This figure is accounted for in great part by the use of heavy dosage scintigrams, by which functional tissue is frequently demonstrable when conventional uptake and excretion studies are negative. Scintigrams were made following the administration of 50 to 70 units of TSH and doses of 2 to 100 mc of radioactive iodine. The complete method of study is given in detail.

Eight illustrative cases demonstrate some pertinent points. The lack of reliability of twenty-four-hour I^{131} uptake and seventy-two hour excretion studies when used alone is made clear. When routine scintigrams are considered negative, scintigrams following heavy dosages of I^{111} may be positive. A scintigram, therefore, should not be considered negative until it has been repeated after a therapeutic dose of 40 to 100 mc of the isotope. In addition, the importance of continuous testing and treatment is stressed. Many patients would not have been treated if the presence of metastatic thyroid tissue had not been recognized with heavy-dosage scintigram technic.

Data are presented which show a lack of correlation

between the initial histologic diagnosis and the collection of radioactive iodine by the metastases.

Eight scintigrams.

C. CHAFFIN, M.D.
Mercy Hospital, Pittsburgh

Treatment of Hyperthyroidism with Radioactive Iodine. Louis J. Levinson. J. M. Soc. New Jersey **56:** 120–123 March 1959. (201 Lyons Ave., Newark, N. J.)

This report from the Newark Beth Israel Hospital reviews the results obtained in the treatment of 390 hyperthyroid patients with I^{131} over the five-year period 1951–1956.

In toxic diffuse goiter (277 cases), radioactive iodine caused a satisfactory remission and cure of hyperthyroidism in 90 per cent of all patients followed for at least a year.

In 44 cases of toxic nodular goiter, satisfactory results were also obtained, but larger doses and a longer interval were required for a remission of the hyperthyroidism. In spite of the larger dosages in this series, there was no instance of hypothyroidism following therapy.

Sixty-nine patients had recurrent postsurgical hyperthyroidism. Of these, 58 are reported cured and 5 improved.

Hypothyroidism was the only significant complication, occurring in 6 per cent of the total number of patients treated. This was readily controlled by the oral administration of desiccated thyroid extract.

Ten patients died; 3 of causes unrelated to hyperthyroidism. The other 7 had a prolonged history of hyperthyroidism or recurrent postsurgical hyperthyroidism; all had severe cardiac damage at the onset of therapy.

Three tables.

Transformation of a Low Grade Papillary Carcinoma of the Thyroid to an Anaplastic Carcinoma After Treatment with Radioiodine. George Crile, Jr., and Donald H. Wilson. Surg., Gynec. & Obst. **108:** 357–360, March 1959. (Cleveland Clinic Foundation, Cleveland, Ohio)

The authors cite experimental and clinical evidence suggesting that many differentiated cancers of the thyroid are "endocrine dependent." Not only is the rate of growth of these cancers increased by any treatment that induces hypothyroidism and increases the output of thyroid-stimulating hormone (TSH), but prolonged stimulation by TSH may convert a low-grade, differentiated, and endocrine-dependent tumor into a highly malignant anaplastic cancer that is no longer dependent on TSH.

A case is reported in which a low-grade papillary carcinoma that had shown no tendency to grow during a period of thirty-four years was transformed into a highly undifferentiated, rapidly growing, autonomous cancer following a period of myxedema induced by treatment with I^{131}. During the thirty years before treatment neither the primary cancer nor its metastases had enlarged. It is postulated that the increased output of thyroid-stimulating hormone induced by the treatment with I^{131} either initiated the transformation of the tumor to an undifferentiated and autonomous type or promoted the growth of dormant cancer cells.

Most tumors that are sufficiently differentiated to take up radioiodine are still dependent on thyroid-stimulating hormone for their continued growth. Most such tumors cease growing or shrink when the output of TSH is suppressed by feeding thyroid. Since treatment of thyroid cancer by thyroid feeding is attended by no risk of increasing the growth energy of the cancer, the authors suggest that a trial on thyroid be given before I^{131} is used. Furthermore, if I^{131} is to be used, the period of myxedema should be as short as possible.

Two photomicrographs.

JOSEPH M. WINSTON, M.D.
University of Pennsylvania

Blood Absorptive Patterns of Isotopically-Labeled Fat and Fatty Acid. Donald Berkowitz, David Sklaroff, Asher Woldow, A. Gerson Jacobs, and William Likoff. Ann. Int. Med. **50:** 247–256, February 1959. (Albert Einstein Medical Center, Northern Division, Philadelphia, Penna.)

The blood-absorptive patterns of isotopically labeled fat or fatty acid afford a new and effective tool for studying various conditions associated with abnormal lipid metabolism, such as those arising from decreased intestinal absorption and those produced by a derangement in fat utilization, transport, or storage. Various primary and secondary malabsorption syndromes, including idiopathic sprue and pancreatogenous steatorrhea, are classified in the first group, while the essential lipoidoses, atherosclerosis, and possibly obesity are believed to belong in the second.

The technic of the test (described in detail in Arch. Int. Med. **100:** 951, 1957) consists essentially in the administration of a fat meal containing 25 microcuries of I^{131}-triolein or oleic acid in a total volume of 1 milliliter of peanut oil per kilogram of body weight. Thereafter, venous blood samples are withdrawn periodically until a maximal radioactivity level has been reached, and then again after twenty-four hours. The radioactivity in each sample, as well as in the twenty-four-hour urine and stool collections, is determined and expressed as a percentage of the initially ingested fat.

The authors at the time of this report had made over 500 such studies. They believe the test may be used diagnostically either to determine the etiology of steatorrhea or the site of jaundice, or to evaluate the degree of fat malabsorption in regional ileitis, sprue, congestive failure, and other diseases before and after treatment. In addition, tolerance tests in coronary atherosclerosis, hypercholesterolemia, and obesity may be used to follow the fate of ingested fat in a much simpler and more precise manner than is now available.

It is thought that future modifications of the procedure, with extensions into wider spheres, should result in much valuable information concerned with basic metabolic mechanisms.

Eight figures; 2 tables.

Hypophyseal Changes in Hypothyroidism Induced by Radioactive Iodine in Man. Agnes Burt Russfield. Arch. Path. **66:** 79–88, July 1958. (Massachusetts General Hospital, Boston 14, Mass.)

The hypophyses of 12 patients who had received from 9 to 1,289 mc of I^{131} from three weeks to ten years before death were compared with the hypophyses of 15 patients of similar thyroid status who had not received radioactive iodine. In both groups clinical thyroid deficiency tended to increase hypophyseal weight and the relative percentage of sparsely granu-

lated amphophilic cells. In both groups the histologic effects of myxedema appeared to be reversed by thyroid or iodide therapy. The changes produced by I^{131} were related to the thyroid status of the patient but not to the total amount of drug administered. In no case was there any anatomic evidence of radiation damage to the hypophysis.

The thyroid of patients dying within a month after the administration of I^{131} showed focal radiation necrosis. In those surviving for longer periods, the thyroid tended to decrease in weight and to show increased fibrosis and lymphocytes. Giant hyperchromatic nuclei appeared; however, these were also found in one patient given propylthiouracil and in several with spontaneous myxedema, suggesting that they were secondary to hypophyseal stimulation rather than to radiation *per se*.

The author concludes that the hypophyseal amphophils are the most probable source of thyrotropic hormone. The possibility that thyroid deficiency may have produced microscopic hypophyseal adenomas and that there may exist a relationship between hypophyseal changes and growth of thyroid tumors is discussed.

Six photomicrographs; 6 tables.

Transport of Radioiodide Between Thyroid Gland and Blood in Mice and Rats. Seymour H. Wollman and Franklin E. Reed. Am. J. Physiol. **196:** 113–120, January 1959. (National Cancer Institute, National Institutes of Health, Bethesda, Md.)

Equilibration data were obtained for thyroids of various activities in rats and mice given a single dose of propylthiouracil to block organic binding or radioiodine. [In this paper, thyroid activity refers to metabolic activity of the thyroid associated with a particular rate of secretion of thyroid-stimulating hormone and a given level of iodine in the diet. It does not refer to the rate of secretion of thyroid hormone.] Data were compared with observations on an open two-compartment model of the thyroid characterized by a one-way thyroid clearance of serum radioiodide and an exit rate constant for the transport of radioiodide from the thyroid to the blood. The model generally fitted the data within experimental error. Clearances increased with thyroid activity. Exit rate constants were much larger for animals fed thiouracil than for other animals. Thiocyanate increased the exit rate constant but did not change the thyroid clearance of serum radioiodide significantly. A new open three-compartment thyroid model was constructed and is used to explain how thiocyanate could increase the exit rate constant by inhibiting the transport of iodide from the follicular cells to the lumen of the follicle.

Thirteen graphs; 1 drawing; 1 table.

The Advantages and Limitations of Cobalt 60 Hectocurie Teletherapy. Norman Simon and Sidney M. Silverstone. Am. J. Roentgenol. **81:** 38–42, January 1959. (945 Fifth Ave., New York, N. Y.)

The beneficial features of cobalt-60 teletherapy include: (1) skin sparing; (2) increased depth dose; (3) lessened bone absorption; (4) decreased side scatter; (5) simplicity of operation.

The skin sparing of the cobalt-60 beam allows high dosage through single portals and may even provide access to lesions which are not usually considered treatable. It allows the use of high dosage through single portals and makes possible simplified and efficient treatment of relatively superficial lesions. For example, with conventional therapy it is difficult to treat the thyroid with more than 3,500 r, but with cobalt-60 teletherapy 6,000 r can be delivered to the gland through a single anterior portal.

The increase in depth dose with cobalt-60 teletherapy is often considered to be the major advantage of this form of therapy, although there are no deep seated lesions which cannot receive a cancerocidal dose with 200 kv radiation with multiple fields or rotation. The limit to dosage in deep-seated lesions depends on the radiosensitivity of adjacent organs. The tolerance of adjacent normal tissues is no greater for cobalt 60 than for conventional radiation.

The lessened absorption of radiation by bone increases the dose to tissues beneath bone, such as the brain and pelvic organs. It is also felt that radionecrosis of bone may be lessened.

The decreased side-scatter of the cobalt 60 beam is presumed to account for the decreased radiation sickness.

A cobalt-60 hectocurie apparatus is far simpler to operate than 200-kv or supervoltage roentgen-ray machines.

The limitations of cobalt-60 hectocurie therapy, as compared to 200-kv roentgen therapy, include: (1) unsuitability for intra-oral (and intravaginal) therapy; (2) unsuitability for treatment of skin cancer; (3) reduced usefulness of the large fields; (4) too much penumbra at long source-skin distances; (5) requirements of radiation protection of operating personnel. The use of cobalt-60 teletherapy for intra-oral lesions would result in useless irradiation to much normal tissue. The method would obviously not be suitable for treating skin lesions by the very nature of its skin-sparing effect.

Protection remains the most serious problem in cobalt-60 teletherapy, for even in the "off" position, emission of minimal radiation continues. The radiation received by personnel using the machine can, however, be kept below the permissible levels with proper care and supervision.

Five photographs; 1 table.

DEAN W. GEHEBER, M.D.
Baton Rouge, La.

Radioactive Phosphate Concentration in the Cerebral Cortex. Louis Bakay. Neurology **9:** 18–23, January 1959. (Massachusetts General Hospital, Boston, Mass.)

It has previously been shown that, after administration of radioactive phosphate, the highest relative specific activity is obtained in the surface areas of the brain, that is, in the superficial layers of the cortex and in the walls of the ventricles, the pattern being the same whether P^{32} is injected intravenously or directly into the cerebrospinal fluid. It is the author's purpose to correlate this observation with our present knowledge of cortical histology and histochemistry.

The laminar distribution of P^{32} was determined by radioautography and tissue analysis in both cats and in human brains recovered at autopsy. During the first hour, P^{32} concentrated mostly in laminae I and II. Later, the zone of high concentration gradually involved the third and fourth laminae, and eventually the entire cortex and subcortical white matter. The concentration gradient from surface to depth dimin-

ished with time, but was still noticeable four weeks after injection.

This pattern of P^{32} deposition cannot be explained by the volume of cells in various cortical laminae. S-55 labeled methionine is known to concentrate in individual cells and its deposition shows a direct relationship between maximum specific activity and cell population not demonstrated for P^{32}. Recent publications contain data on the architectonic distribution of enzymes regulating cellular respiration and phosphorylation, and it is interesting that they form a laminar pattern superficially resembling the phosphate deposition.

In spite of this, the author believes that the P^{32} concentration of various layers of the cortex at different time intervals can best be explained by assuming that the great bulk of the isotope penetrates its surface from the outside and advances into the deeper layers by physical diffusion from the cerebrospinal fluid.

Six radioautographs; 2 photographs; 2 graphs.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

The Production of Osteogenic Sarcomas in Rats with Radioactive Calcium. LeRoy L. Barnes, Gladys Sperling, C. M. McCay, and Clark E. Brown. Arch. Path. **66**: 529–535, October 1958. (C. E. B., Lankenau Hospital, Philadelphia 31, Penna.)

An investigation was made of the incidence of osteogenic sarcomas in white rats given Ca^{45} at thirty days of age. Two experiments were performed. In the first, 4 groups of rats (Groups I, II, IV, and V) received Ca^{45} at 48-hour intervals throughout the dosage period, for a total dose per rat of 42, 106, 360, and 785 μc, respectively. The second experiment was interrupted because of the illness of one of the authors, and the animals in Groups III and VI received four doses of Ca^{45} at weekly intervals and, after skipping four weeks, received two more doses at weekly intervals, for a total dose of 200 and 971 μc, respectively.

No bone tumors were found in the rats in Groups I and II. Bone sarcomas were found in 1 rat in Group III and in 1 in Group IV. In Group V, 12 of the 13 rats had one or more bone tumors. In Group VI, 16 of the 20 rats had one or more bone tumors (1 was classified as osteoma, 15 as osteogenic sarcoma). Two of the 4 rats without tumor had paralysis of the hindlegs, which was characteristic of all those rats with a tumor on the spine.

Forty-three osteogenic sarcomas were found in 29 animals; 30 were located in the long bones; 7 in vertebrae; 3 in rib or sternum; 3 in the shoulder area. Ten of the 29 tumor-bearing rats had multiple primary osteogenic sarcomas; metastasis occurred in all of these. Nine of the 19 rats with single osteogenic sarcomas also had metastases.

In Group V the average interval from the first dose of Ca^{45} until the appearance of a tumor or paralysis of the hindlegs was two hundred and seven days. The average time from the appearance of tumor or paralysis until death was twenty-one days.

In Group VI the average interval from the last dose until appearance of a tumor or paralysis was one hundred and fifty-five days, and the average interval from the first appearance of a tumor or paralysis until death was twenty-six days.

The considerable amount of neoplastic cartilage in some of the tumors suggests that Ca^{45} is deposited in calcifying cartilage as well as in bone.

The authors conclude that total doses of less than 1 μc per gram of rat are not likely to produce osteogenic sarcoma.

Ca^{45}, as given in this experiment, produced no effect on the blood cell counts of the rats during the ensuing six months.

Four roentgenograms; 4 photomicrographs; 1 table.

Iron-59 Metabolism as an Index of Erythropoietic Damage and Recovery in Monkeys Exposed to Nuclear Radiations. Quentin L. Hartwig, George S. Melville, Jr., Thomas P. Leffingwell, and Robert J. Young. Am. J. Physiol. **196**: 156–158, January 1959. (Q. L. H., Louisiana State University School of Medicine, New Orleans 12, La.)

Monkeys exposed to mixed neutron and gamma radiation from a nuclear device were studied for changes in radioiron utilization by erythrogenic tissues. Twenty-eight hours after exposure, $Fe^{59}Cl_3$ was injected; twenty-four hours later the first blood sample was drawn. Iron incorporation by the irradiated animals indicated marked erythropoietic depression. At fifty-two hours after exposure, average uptake in irradiated animals was 2.1 per cent as compared to 10.7 per cent in the controls. Only 3 of the original 10 irradiated monkeys survived. On repeating iron-59 injection in supplemented groups of survivors thirty-four days after exposure, repair and active erythropoiesis were evident. Plasma iron determinations demonstrated periods of both hyper- and hypoferremia. Those animals which died were consistently hypoferremic for two to three days prior to death.

Three graphs.

Total Thoracic Supervoltage Irradiation Followed by the Intravenous Infusion of Stored Autogenous Marrow. K. A. Newton, J. G. Humble, C. W. Wilson, D. E. Pegg, and M. E. G. Skinner. Brit. M. J. 1: 531–535, Feb. 28, 1959. (Westminster Hospital, London, England)

The treatment of disseminated radiosensitive tumor by large-volume, high-voltage radiation is limited by radiation damage to bone marrow and subsequent lowering of the circulating blood elements. The authors have used large-volume supervoltage therapy with a total tissue dose of 3,000 r to the entire thorax in 2 cases of metastatic pulmonary disease. To combat hematologic depression, bone marrow was withdrawn from the iliac crests and sternum before the beginning of treatment, was stored under refrigeration, and administered to the patient intravenously at the end of radiation therapy. The technic of bone marrow withdrawal, preparation, and storage is described in detail. No undue effect on the patient was noted from autogenous bone marrow administration.

The hematologic response to the bone marrow infusion was an immediate rise in the total circulating white cells. This rise, the authors believe, is not explained only by marrow repopulation; they suggest the presence, in the marrow, of a humoral, non-cellular hemopoietic stimulant.

The two cases presented in this paper illustrate the good hematological response to autogenous marrow

injection. Both patients received 2-Mev radiation over the entire thorax, for a large total tissue dose (3,000 r) within two weeks. In one patient metastatic nodules in the lung (from Ewing's sarcoma) completely disappeared. No constitutional disturbances were encountered in either case during the two weeks of treatment. The possible immediate application of this technic is extension of treatment volumes when indicated.

Seven figures, including 2 roentgenograms; 3 tables.

J. S. ARAJ, M.D.
Toledo, Ohio

RADIATION EFFECTS

Delayed Effects of Ionizing Radiations in Man. John L. Tullis. Arch. Path. **66:** 403–417, October 1958. (New England Deaconess Hospital, Boston 15, Mass.)

The author reviews the literature on the delayed effects of ionizing radiations in man. Sections are devoted to the skin; leukemia; thyroid cancer; congenital and developmental hazards; respiratory system; lesions in dial painters and in patients treated with radium salts; lesions in patients with retained colloidal thorium dioxide (Thorotrast); bone; nasopharynx; female pelvic organs; late hematological effects; cataracts; and shortening of life span and aging.

The following conclusions are reached:

"Any given response to irradiation is the result of the interplay of many physical factors which acting together characterize the agent and many biological factors which acting together determine the host's response to the agent. A great deal is known about the physical factors, and the agent can be more or less tailored to desired specifications. The host's response and the finer details of biologic mechanisms are, on the other hand, shrouded in mystery and are not often in our present state of knowledge subject to effective alteration. Some of the delayed effects of exposure to ionizing radiations may be so slight that they are not recognized and their importance is not appreciated. This is particularly true at low dose levels, where the defense and repair capabilities of the body may be sufficient to mask or reverse smaller degrees of damage. The struggle may be prolonged, but in time, if the damage has not been severe enough and the host's response not effective enough, the injury becomes manifest. A long, usually symptom-free, latent period is characteristic of many radiation-induced lesions. The total number of known cases in most categories of delayed effects is small, and the amount of radiation required to produce the more serious effects is large. Radiation-induced malignant diseases number fewer than 100 cases in each of the several categories, and the induction doses are usually 1,000 r at a minimum but on the average are nearer 3,000 r.

"The important thing to recognize is that serious delayed effects in man can be caused by exposure to ionizing radiations. In the past significant exposures have been sustained because of ignorance, carelessness, and accidents. There is still much to be learned about low and cumulative dose effects and about the existence of a threshold. Great strides have been made in the understanding of protective devices and in generating an awareness of the potential dangers in unwise use of ionizing radiations. As agents in diagnosis and therapy they have saved and prolonged life and immeasurably facilitated the practice of medicine. They have opened great new fields of medical, biological, and physical sciences research. . . . The careful use of protective devices and the avoidance of unwarranted use of even the slightest amount of ionizing radiations are hallmarks of enlightened modern medical practice. There is no cause for curtailment of any clearly indicated medical use of ionizing radiations, but, particularly in children, young adults, and pregnant women, and in benign diseases, the indications for their use must be carefully reviewed, appraised, and justified."

A bibliography of 128 references is appended.

Carcinoma of the Thyroid in Children After X-Ray Therapy in Early Childhood. Donald R. Rooney and R. Waldo Powell. J.A.M.A. **169:** 1–4, Jan. 3, 1959. (Emory University School of Medicine, Atlanta, Ga.)

Ten cases of carcinoma of the thyroid are reported in children seventeen years of age or younger; 7 of these had received radiation therapy to the mediastinum in early childhood for various benign conditions. In 2 of the remaining 3 no definite positive or negative statement could be obtained regarding previous radiation exposure. An indication of such exposure was usually not included in otherwise complete hospital charts, and specific inquiry was necessary to obtain this information.

A total of 121 examples of thyroid carcinoma in children have thus far been reported. Approximately one-third of the patients were known to have received radiation therapy to the head, neck, or thorax.

The increased incidence of thyroid carcinoma in children correlates, among other things, with the formerly prevalent use of x-ray therapy for benign conditions in this age group. The authors state that, although further studies are needed before mediastinal irradiation in children can be causally linked to the development of thyroid carcinoma, these young patients, with few or no exceptions, should be protected from all ionizing radiation for nonmalignant conditions.

Two tables.

WILLIAM MARTEL, M.D.
University Hospital, Ann Arbor

Radiation Injury to the Sigmoid and Rectum. Bentley P. Colcock and Alan Hume. Surg., Gynec. & Obst. **108:** 306–312, March 1959. (Lahey Clinic, Boston, Mass.)

The authors report a series of 41 cases of serious injury to the rectum and small intestine or to the sigmoid or rectum alone as a result of radiation therapy for pelvic cancer. The incidence of such complications of irradiation has been variously reported.

Five patients in the present series died as a result of injury to the small bowel, and 1 of these cases is presented in some detail. The symptoms are usually those of intermittent obstruction—weight loss, nausea

and vomiting, and crampy, intermittent abdominal pain. These symptoms are often indistinguishable from those of recurrent carcinoma and in their presence exploratory laparotomy is indicated.

Patients with damage to the sigmoid or rectum presented with symptoms of proctitis or rectal stricture. Twenty-two of the 41 patients had a severe proctitis and 12 had rectal strictures. The average time for onset of symptoms was four months following the first treatment for the patients who survived and 2.4 months after the first treatment for those dying of recurrent disease.

With the increasing use of radiation, surgeons may anticipate the necessity of dealing with this type of injury more frequently. Hospitalization and intensive conservative treatment of patients with severe proctitis may provide relief and eliminate the necessity for operation. If conservative measures fail, a temporary colostomy may be sufficient to permit the acute process in the rectum or sigmoid to subside.

The salient features of the authors' cases are presented in two tables.

WALLACE T. MILLER, M.D.
University of Pennsylvania

Late Irradiation Changes: A Cytological Study of Cervical and Vaginal Smears. Thomas S. Zimmer. Cancer **12:** 193–196, January-February 1959. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

The author examined the vaginal and cervical smears of 19 patients who had been treated between eleven months and fourteen years previously for carcinoma of the uterine cervix by irradiation. The cytological picture differed from a group of 100 sets of smears from postmenopausal patients free of cancer used as controls.

It can be safely assumed that there is a causative connection between treatment and findings in these cases, possibly *via* mutation of the genes of the germinal layer. Cytologic changes consistent with late radiation effects were found as late as fourteen years after completion of treatment. The reaction varied individually, and was independent of such factors as the dose or mode of irradiation, age of patient, or extent of disease.

Variations in the extent of the late irradiation change proved to have no prognostic significance. The findings could occasionally be confused with cancer. A complete history should therefore be elicited whenever changes suggesting past radiation treatment are noted, to allow evaluation and explanation of unusual cytological findings that otherwise may become a source of false interpretation or, at least, a puzzle.

Six photomicrographs; 1 table.

CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

Radiation Doses to the Gonads of Patients in Swedish Roentgen Diagnostics. Studies on Magnitude and Variation of the Gonad Doses Together with Dose Reducing Measures. Lars-Eric Larsson. Acta radiol. Suppl. 157, 1958. (Karolinska Sjukhuset, Stockholm, Sweden)

Careful measurements of radiation dose incident to most types of roentgen examinations were recorded and analyzed, on the basis of statistically significant numbers. The variations in gonadal doses due to different technics and examiners are described. Attention to the basic principles of careful diaphragming, good filtration, and a minimum number of exposures produced the most favorable readings.

The age distribution of patients in relation to type of examination is plotted and "genetically significant" radiation calculated for Sweden. The figure arrived at is 72 mr (including fetal irradiation) but it is believed that this could be reduced to 28 mr by the institution of such protective measures as the following:

1. The use of lead-rubber protection over the scrotum in intravenous urography, examinations of bones, and abdominal survey examinations.
2. Exclusion of special radiographs in examinations of the lumbar and sacral spine, obstetric abdominal examinations, and intravenous urography in children.
3. Change of procedures in urethrocystography.
4. The more restricted use of obstetric examinations.

Thirty-two illustrations; 58 tables.

WILLIAM R. EYLER, M.D.
The Henry Ford Hospital

Radium in Human Bone: The Microradiographic Appearance. R. E. Rowland, J. H. Marshall, and J. Jowsey. Radiation Res. **10:** 323–334, March 1959. (Radiological Physics Division, Argonne National Laboratory, Lemont, Ill.)

In this report the authors describe the microradiographic appearance of lesions in bones of persons burdened with radium. Samples of cortical bone from the tibia and/or femur from 15 individuals with terminal Ra^{226} burdens of 0.8 to 10.5 μc and from 17 persons, from fifty to eighty years of age with no history of radium exposure, were examined.

In microradiographs of thin sections of undecalcified bone the pattern of mineral densities that exist in various structures, such as the haversian systems, are revealed by regions of various opacities, whereas the blood-carrying haversian canals, the lacunae of the osteocytes, and the resorption tunnels appear as dark regions in which no material is present. The differences between normal and radium-bearing bone demonstrable by the microradiographic technic are therefore changes in the inorganic content of these structures.

The most characteristic change in bones burdened with radium was the plugging of the haversian canal with mineral of a density higher than that of normal bone. These plugged canals were found in 14 of the authors' 15 cases.

A second abnormality noted in the microradiographs was that a major fraction of, or even an entire, haversian system appeared to have a mineral density as high as that found in the plugged canals. These systems contained apparently normal lacunae and an unplugged central canal, and they usually extended about 1 mm. in length. Often they seemed to end in a resorption cavity. Such systems were not found to be hotspots.

A third type of increased mineralization that was encountered was one in which the lacunae, which normally contain osteocytes, were filled with mineral and appeared more dense than the surrounding bone. Mono-energetic x-ray analysis of these regions indicated that they contained both calcium and phosphorus,

although they were too small in area to permit quantitative analysis. Since hydroxyapatite is one of the most dense minerals containing both of these elements, it appears reasonable to assume this composition for the mineral in the cavities. Such filled lacunae were often seen in microradiographs of bone sections from human subjects over fifty years of age. Those seen in the control samples, however, always had apparently normal lacunae intermixed with them, whereas in the radium cases often all the lacunae in a region were filled. The regions containing filled lacunae were not radium hotspots.

Two unusual types of mineral resorption were found in the microradiographs of radium-bearing bone—one, enlarged lacunae with poorly defined edges, giving the impression that the mineral is dissolving around them, and the other, characterized by smooth-walled alcoves which define the edges of a resorption cavity. Often a line of spherical cavities, 20 to 30 μ in diameter, extended out from the area of resorption into the compact bone, looking very much like a tunnel formed by a chain of hollow beads. This bizarre resorption was found to occur to a much smaller extent in control bone sections where rapid resorption was known to be taking place.

Gross x-ray studies of the long bones of human beings burdened with radium show regions of reduced density in the cortex. When such regions were examined by the microradiographic technic, they were found to be made up of many large cavities in the cortical bone, rather than one large hole. Sometimes, however, the resorption seemed to start at the periosteal or endosteal surface and erode a single large hole into the cortical bone.

The particular microradiographic changes described are not held to be specific to radiation-damaged bone. Their frequent and widespread appearance in radium-bearing bone, however, may give an indication of the abnormal metabolic processes occurring under the influence of continued irradiation.

Eight microradiographs; 2 tables.

An Experimental Study of the Effect of External Irradiation on a "Primary" Tumor and Its Distant Metastases. Peter D. Olch, Richard V. Eck, and Robert R. Smith. Cancer **12**: 23–26, January-February 1959. (National Cancer Institute, Bethesda, Md.)

The authors undertook an experimental study in an attempt to answer the question as to why in some individuals distant metastases suddenly become clinically apparent shortly after therapy of the primary tumor, in this instance irradiation. A transplantable melanoma was injected into the leg in a large number of mice. The number of grossly visible pulmonary metastases was determined in a group receiving local irradiation to the tumor and in an unirradiated control group.

There appeared to be a dual response to irradiation in respect to the number of pulmonary metastases. In the majority of the irradiated groups there were fewer metastases than in the controls, as might be expected. There was, however, a small group (11 animals) in which the number of metastases was markedly increased, several of the animals having more than twice the number of metastases found in the control mouse with the greatest number.

In attempting to explain this dual response, the authors suggest the existence of a delicate balance between the factors promoting localization and destruction of a tumor and the factors encouraging its growth and distant spread. Speculations as to the latter are cited. One hypothesis is a transient disturbance in the tumor-host relationship locally involving the blood supply of the tumor, in which disruption of the vessel walls permits an increased embolization of tumor cells. Another relates to the degree of cohesiveness of tumor cells and the effect of irradiation on this phenomenon, thereby promoting distant spread.

The authors conclude that the mechanism of the apparent increase in number of metastases in a few animals after irradiation remains unexplained. They suggest that the situation may possibly be comparable to that seldom documented but often suggested impression of distant metastases in man, first becoming clinically apparent after irradiation.

Three graphs. CHARLES M. GREENWALD, M.D.
Iowa City, Iowa

Late Effects of Total-Body Roentgen Irradiation. III. Early Appearance of Neoplasms and Life-Shortening in Female Wistar Rats Surviving 1000 r Hypoxic Total-Body Irradiation. Baldwin G. Lamson, Marta S. Billings, Ray A. Meek, and Leslie R. Bennett. Arch. Path. **66**: 311–321, September 1958. (University of California School of Medicine, Los Angeles 24, Calif.)

Eighty-three female Wistar rats surviving, for thirty days, a single exposure to 1,000 r hypoxic total-body x-irradiation at four months of age and 84 controls of the same stock were observed throughout their life span. The irradiated animals all died within two years of exposure, with a mean survival time of fifteen months. This represents a 39 per cent shortening of postirradiation life span, compared to the mean survival of the controls (twenty-four and a half months). This reduction of life span following hypoxic irradiation is comparable to that reported in rodents following total-body irradiation in air, if the dose is expressed in each instance as a per cent of the LD-50 dose. The irradiated animals were also retarded in growth, weighing approximately 18 per cent less than the controls twenty months postirradiation.

Cataracts developed in all rats surviving at least nine and a half months, with a mean appearance time of ten and a half months. Aged control rats also acquired cataracts, appearing first at twenty-six and a half months.

Large pituitary adenomas were common in the controls but absent in the irradiated animals.

Other major pathologic findings in the irradiated rats were closely similar to those found in the controls of advanced age.

Tumors, as a whole, appeared sooner in the irradiated rats but not in greater final numbers. The incidence of tumors in both irradiated and control series generally followed the pattern characteristic of the animal strain, with reproductive and endocrine loci predominating. Ovarian tumors seemed to be specifically increased by the irradiation exposure. Lymphomas were not increased or accelerated by irradiation under the conditions of the experiment in this low-incidence strain.

In general, the early onset of neoplasia in the irradiated rat seems best explained as one aspect of an accelerated aging process. Other diseases prev-

alent in aged rats, such as cataracts, acute inflammations, epilation, and skin ulcerations, were accelerated to a comparable degree.

[The first two studies in this series appeared, respectively, in Radiology **61:** 411, 1953, and Archives of Pathology **64:** 505, 1957 (Abst. in Radiology **71:** 474, 1958). An abstract of a fourth paper follows.—Ed.]

Two charts; 6 tables.

Late Effects of Total-Body Roentgen Irradiation. IV. Hypertension and Nephrosclerosis in Female Wistar Rats Surviving 1000 r Hypoxic Total-Body Irradiation. Baldwin G. Lamson, Marta S. Billings, Leroy H. Ewell, and Leslie R. Bennett. Arch. Path. **66:** 322–329, September 1958. (University of California School of Medicine, Los Angeles 24, Calif.)

Systolic blood pressure levels were studied in 59 female Wistar rats surviving 1,000 r hypoxic total-body x-irradiation and in 63 controls of the same age. Mean blood pressure of the irradiated rats at monthly intervals from thirteen to twenty-three months postirradiation averaged 39 mm. Hg greater than in the controls of the same age.

Bilateral nephrosclerosis developed in 46 per cent of the irradiated rats. No correlation between duration of hypertension and eventual development of nephrosclerosis could be made, but in no instance did a rat with nephrosclerosis have a normotensive history.

The mean value of maximal blood pressure determinations from individual rats was 193 mm. Hg in the irradiated group, compared to 139 mm. Hg in the controls. Mean blood pressure maxima in the irradiated rats without severe renal disease was almost as high (185 mm.) as in those with nephrosclerosis (202 mm.).

Direct renal irradiation may be necessary to initiate the hypertensive phase of the total-body radiation "late effects" syndrome, but inclusion of the kidneys within the radiation field does not consistently produce nephrosclerosis at the 1,000 r (hypoxic) dose level.

There are unreported observations that this postirradiation nephrosclerosis of total-body exposure does not differ in histologic appearance from the renal lesion observed in nonirradiated rats made hypertensive by unilateral nephrectomy and a 1 per cent salt drinking solution.

[For earlier papers in this series, see preceding abstract and references there cited.—Ed.]

Six tables.

Long-Term Effects of Whole-Body Irradiation on Lymphocyte Homeostasis in the Mouse. D. Metcalf. Radiation Res. **10:** 313–322, March 1959. (Royal Melbourne Hospital, Parkville, Victoria, Australia)

It has been known for a long time that leukemia can be induced in mice by whole-body irradiation. In 1950, Kaplan (J. Nat. Cancer Inst. **11:** 83, 1950) observed that thymectomy prevented the development of radiation-induced lymphoid leukemia, but the exact role of the thymus in leukemogenesis has not been established. The thymus produces a lymphocytosis-stimulating factor (LSF), which occurs in excessive amounts in mice with spontaneous lymphatic leukemia. In the present paper, the author describes the long-term effects of whole-body irradiation in mice on lymphocyte and LSF levels and the responsiveness of the tissues of irradiated mice to stimulation by LSF.

Male mice of the $C_{57}Bl$ strain, four to six weeks old given 250 or 350 r whole-body x-irradiation showed consistently elevated lymphocyte levels three to fifteen months after exposure. The initial lymphopenia was exactly as described by other workers. Serum assays of irradiated mice exhibiting this lymphocytosis revealed elevated levels of LSF. That this excess LSF is, in part, responsible for the lymphocytosis is suggested by the finding that thymectomized mice, after irradiation, showed lymphocyte levels similar to those of nonirradiated mice. Injection of LSF into thymectomized irradiated mice elevated the lymphocyte levels in these mice to those of irradiated sham-operated mice. The evidence, from serum assays of LSF, that thymic LSF production is excessive in irradiated mice was supported by the finding that in such mice lymphocytosis did not develop in response to trauma or to injection of LSF. Thymectomy, possibly by removing the intrinsic source of such excess LSF, enabled irradiated mice to respond normally to injected LSF. The effect of thymectomy was the same whether it was performed before or six months after irradiation. No evidence was obtained that irradiation had altered the responsiveness of the lymphoid cells to the stimulation of injected LSF.

Six graphs.

Time-Intensity Factors in Radiation Response. II. Some Genetic Factors in Brain Damage. Samuel P. Hicks, Kenneth A. Wright, and Constance J. D' Amato. Arch. Path. **66:** 394–402, October 1958. (New England Deaconess Hospital, Boston 15, Mass.)

In a previous study (Arch. Path. **61:** 226, 1956. Abst. in Radiology **68:** 154, 1957), it was shown that, in several strains of mice and in rats, large doses of radiation given in very short periods of time could produce severe damage to the central nervous system or could even be immediately lethal. Extremely intense radiation (30,000 rep of 2.5-Mev electrons in one second, for example) could kill a mouse "instantly," *i.e.*, the animal became convulsive and died within seconds after the irradiation. The authors have now carried out experiments in which the acute effects of large doses on the brains of four strains of mice, DBA/2, DBA/1, LAF_1, and C57 Black 6 were compared. The results are discussed under three headings: differences among strains, nature of the demarcated lesions, and the genetic patterns of brain metabolism and radiation damage.

Differences Among Strains: Three differences between the C57's and the other strains seemed to be clear. One was the resistance of C57's to immediate death from the high dose of radiation. A second was the lag of this group of animals behind the other strains in the development of the lethally convulsive state which was responsible for death during the twenty-four hours after exposure. The third was the conspicuous resistance to histologic damage of the cerebral hemispheres (except the olfactory lobes) in the C57 survivors as compared with the other strains. Of the four strains, LAF_1 seemed to be most susceptible to several of the effects of radiation.

Demarcated Lesions: The appearance of large, usually bilaterally symmetrical lesions, often as severe as an infarct and rather sharply defined, suggested that local vascular factors might be responsible, but there was

no mechanical occlusion, nor did the lesions seem to correspond obviously to arterial supply. Altered permeability of regional vessels to substances usually withheld by blood-brain barriers was another possibility. Interference with venous drainage could be considered, but dilated veins were not always related to the damaged zones. While neither vasospasm nor vasoparalysis are excluded as factors, they would have had to act rapidly, for it is established that radiation necrosis is well developed after as little as four hours.

The often observed fact that many of the damaging effects of radiation in given circumstances may be made worse by an increase in oxygen tension suggests the hypothesis that the zones of extensive necrosis may represent regions with relatively greater oxygen tension than their neighbors because of a relatively richer blood supply. Some of the affected zones were ones with anatomically rich capillary beds and overlapping tributary supplies, while others were not. A "rich blood supply" and correspondingly a "rich oxygen supply," however, is compounded by a number of factors, including rate and volume of boood flow and density and kind of capillary bed. Whether a high oxygen tension extracellularly and intracellularly generally would result would depend on how efficiently the oxygen supply and the oxygen demand of the local cells were balanced against each other in a given region.

Genetic Patterns of Brain Metabolism and Radiation Damage: One aim of the present experiments was to see whether DBA mice with their deficient oxidative phosphorylating enzymes and susceptibility to certain seizure-inducing factors were more prone to certain radiation injuries than C57's. Although the differences noted were found, no simple formula emerges to explain them and there are no clear relations between the facts about the brain metabolism and their susceptibility to radiation effects. Why some of the correlations failed to be realized is discussed and speculations as to others that may exist are advanced.

Three photomicrographs; 1 table.

Lesions of the Tongue in Irradiated Mice. O. Vos, F. Wensinck, and D. W. Van Bekkum. Radiation Res. 10: 339–346, March 1959. (Medical Biological Laboratory of the National Defence Research Council TNO, Rijswijk (Z. H.), The Netherlands)

Postmortem examination of nearly 700 CBA and C57BL mice that died after total-body exposure to 675 and 750 r x-irradiation revealed macroscopic lesions of the tongue in 23 per cent of the animals. Microscopic lesions were found much more frequently. The lesions resembled an abscess or an ulcer and consisted of a heavily infected necrotic mass. Cellular reaction was absent. The possibility that such lesions are the portal of entry for microorganisms in the development of the bacteremia associated with the bone-marrow syndrome is discussed.

Five figures; 3 tables.

Prevention of Late Deaths in X-Irradiated Mice by Injected Hematopoietic Cells from Homologous Newborn Donors. Leonard J. Cole. Am. J. Physiol. 196: 441–444, February 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Previous studies have shown that the injection of spleen cells from normal adult parental strain (A-strain) mice into sublethally x-irradiated (500 r) F_1 hybrid mice ($(LxA)F_1$) is followed by delayed deaths in 100 per cent of the animals. This lethal effect was found by the author to be elicited also by spleen cells from adult L-strain mice but not by spleen cells derived from newborn (one-to-two-day-old) parental strain mice. Following supralethal whole-body x-irradiation (870 r) of LAF mice, the injection of cells from spleen or liver of newborn A-strain mice afforded up to 100 per cent protection against death by the thirtieth day postirradiation; no late "homologous deaths" were seen in the mice which received spleen cells from the newborn A-mice, in contrast to the observations when hematopoietic cells from adult A-mice were injected. The data imply that spleen cells from newborn mice are immunologically nonreactive, and lend further support to the hypothesis that late homologous death (in the context employed here) results primarily from an immunological reaction of the injected cells against the host.

Three tables.

Transfer of Donor Immunological Reactivity to X-Irradiated F_1 Hybrid Mice by Injected Parental Bone Marrow. L. J. Cole, R. M. Garver, and M. E. Ellis. Am. J. Physiol. 196: 100–104, January 1959. (U. S. Naval Radiological Defense Laboratory, San Francisco, Calif.)

Mice of the $(L\times A)F_1$ strain were exposed to an LD 100 dose of x-rays (870 r), and injected with bone-marrow cell suspensions from A-strain (parental strain) mice. Excellent protection against death was observed during the first three weeks, followed by secondary "homologous" deaths during the ensuing weeks. When A-strain spleen cells were injected, together with A-strain bone marrow, the protective effect was annulled. When A-spleen cells were injected together with LAF_1 bone marrow cells into irradiated LAF_1 mice, again no protection was observed. Injected LAF_1 spleen cells, however, did not influence adversely the course of protection of x-irradiated A-strain mice by injected A-bone marrow.

These findings formed the basis for an experimental test system for detecting the presence of A-lymphoid cells in the tissues of irradiated LAF_1 mice which had been injected with A-bone marrow. The data indicate that the spleen and thymus of LAF_1 mice twenty-one days after irradiation and injection of A-marrow contain A-lymphoid cells which, when injected in turn into irradiated LAF_1 mice treated with LAF_1 marrow, annul the protective effect of the injected marrow. It is concluded that a reaction (of an immunological nature) of the injected bone marrow cells, or their progeny, against the host tissues contributes to the phenomenon of the late deaths. The significance of these results with respect to the problem of "homologous disease" in lethally irradiated mice treated with homologous bone marrow is discussed.

Three tables.

The Effects of Single and Divided Doses of X-Radiation on Bone Marrow of Partially Shielded Rats. Raymond G. Murray. Radiation Res. 10: 347–356, March 1959. (Indiana University School of Medicine, Bloomington, Ind.)

Forty-eight rats were exposed in a variety of ways to 200-kvp x-rays with the following results:

1. Bone marrow in an exposed lower quadrant which received 900 r in five daily fractions of 180 r

while the remaining three-fourths of the rat was shielded showed less recovery at ten to twelve days than marrow which received 525 r of total-body irradiation in a single dose. The fact that partial shielding and dividing the dose did not give more protection suggests that these two protective mechanisms are not additive.

2. Mild irradiation (5 × 13 r) appeared to produce slight but measurable resistance to a heavy (525 r) dose of x-rays delivered at three days or ten days after the mild treatment.

3. Plasma cells were undamaged by 525 r or 5 × 180 r and increased significantly in the marrow five and ten days after irradiation by transformations from hemocytoblasts, and possibly from early erythroblasts and myelocytes.

Two tables.

An Evaluation of Some Genetic Factors Influencing Irradiation Protection by Bone Marrow. Delta E. Uphoff and L. W. Law. J. Nat. Cancer Inst. **22:** 229–241, February 1959. (National Cancer Institute, Bethesda, Md.)

In an effort to evaluate some genetic factors influencing irradiation protection by bone marrow, mice three to four months old were exposed to a thirty-day LD 98 of total-body x-irradiation, *i.e.*, 700 or 800 r, depending on the strain treated. All irradiated mice were randomized, and tail-vein inoculations of marrow from 4 long bone equivalents were completed within three hours of irradiation. Three groups of animals were studied: an irradiated control (noninoculated) group, the irradiated group receiving isologous marrow, and a group receiving co-isologous marrow.

A single gene difference at the H-2 locus provided sufficient basis for the severe reaction of the secondary phase of the irradiation syndrome. The H-1 locus provided a variable reaction, while the H-3 locus produced no reaction. In the testing of 27 inbred strain combinations, no good long-term survival was observed when the strains were of different H-2 phenotypes. Nine inbred-strain combinations in which the marrow donor and the recipient were of the same H-2 phenotype, either H-2^b or H-2^d, were found to be compatible. Hybrids of the genotype H-2^d/H-2^k were tested against strain A and gave further evidence that an immune response of the graft against the host was responsible for the secondary phase. A gene-dosage effect was proposed as a working hypothesis to explain the variability in response observed in F_1 hybrids treated with parental-strain marrow in contrast to the response found among different inbred-strain combinations. Evidence for a threshold effect in antigen-antibody response of F_1 hybrid mice treated with parental-strain marrow is discussed.

One photograph; 5 tables.

Fibrosis in Rats' Lungs Produced by Radioactive Mine Dust. B. F. Thiart and F. M. Engelbrecht. South African M. J. **33:** 204–207, March 7, 1959. (University of Stellenbosch, Stellenbosch, Union of South Africa)

Previous studies by others have shown an extremely dangerous silicotic effect referable to gold-bearing rock encountered in South African mines. It occurred to the authors that a possible contributing factor in the pathogenesis of silicotic fibrosis might be the presence of radioactive material in this rock. An experiment was set up to test the fibrotic response caused by selected dust samples specially prepared and injected in single 50 mg. doses into the tracheas of 100 rats divided into 5 groups. Animals were sacrificed at intervals from 30 to 320 days and histologic studies were performed on lung tissues. The most severe classical findings of experimental silicosis developed in the group receiving Snowit (Belgian quartz dust containing 94 per cent silica, utilized in control study and not found in the mines under study). All of the original mine dust samples produced varying degrees of silicosis but with fibrosis developing more slowly and less extensively than in the control group. In the presence of radioactive material no correlation was found between the silica content of the samples and the severity of fibrosis produced. Animals sacrificed in earlier stages of the experiment demonstrated greater fibrosis when their dust samples contained radioactive material than with nonradioactive samples. In the later stages of the experiment no marked difference was observed between radioactive and nonradioactive dusts. It is felt by the authors that the presence of radioactive material in the Witwatersrand mine dust contributes to its exceptional fibrogenetic activity.

Five photomicrographs; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Cancerigenic Potential of Thermal Injury in the Skin of Whole-Body Irradiated Rats. Oscar A. Ross, Pliny Keep, and Alan R. Moritz. Arch. Path. **67:** 211–214, February 1959. (Western Reserve University, 2085 Adelbert Rd., Cleveland 6, Ohio)

Thirty-three of 100 rats that survived a single dose of total-body x-irradiation (620 r) for more than thirty days were followed until death. Deep thermal burns of the skin were produced at intervals between sixty-two and three hundred and sixty-eight days after irradiation. Complete autopsy of the animals failed to reveal evidence of tumor formation in any of 156 burn scars, although 62 neoplasms, both benign and malignant, involving all organ systems with the exception of the cardiovascular, were discovered. The results of this study indicate that severe cutaneous burning in a Wistar rat predisposed to neoplasia by total-body irradiation does not result in localization of tumors at the sites of the burns.

Three tables.

Carcinogenic Activity of Cigarette-Smoke Condensate. I. Effect of Trauma and Remote X Irradiation. Fred G. Bock and George E. Moore. J. Nat. Cancer Inst. **22:** 401–411, February 1959. (Roswell Park Memorial Institute, Buffalo, N. Y.)

Studies were made on the effects in Swiss female mice and C3H males of combining x-irradiation and skin-painting with cigarette-smoke condensates: "A," approximately 20 per cent tar, and "B," a concentrated fraction containing the bulk of the polynuclear aromatic hydrocarbons.

There were 13 groups of animals: (1) 30 mice shaved on alternate Mondays just before painting with "A"; (2) 30 controls treated as above but painted with acetone; (3) 30 mice shaved the first Friday of each month and painted (with "A") the following Monday; (4) 30 mice shaved "when it appeared necessary"; painted with "A"; (5) 30 mice rubbed with sandpaper three times weekly just vigorously enough to induce slight

bleeding before painting with "A"; (6) 10 controls treated like those in Group 5 but painted with acetone; (7) 30 mice that were never shaved; painted with "A"; (8) 10 control mice that were never shaved; painted with acetone; (9) 50 nonirradiated Swiss female mice painted with "B"; (10) 65 irradiated Swiss female mice painted with "B"; (11) 39 irradiated Swiss female mice serving as controls for Group 10; painted with acetone; (12) 45 irradiated C3H males pianted with "B"; (13) 19 irradiated C3H males, controls for Group 12; painted with acetone.

Physical irradiation factors were h.v.l. 0.1 mm. Al (100 kv, unfiltered) and a dose rate of 780 r per minute at a distance of 20 cm. A single dose of 2,500 r was delivered when the animals were fifty-five days of age. At that time the dorsal hair was in a resting stage of growth. The animals were placed in individual lead containers with wall thicknesses of 1/16 to 1/8 inch, in each of which there was a 1 × 1-cm. window permitting radiation of 1 sq. cm. of the dorsum of the mouse just anterior to the tail. With this dose of 2,500 r delivered to the skin, the dose scattered to the interior of the mouse under the lead shield was found to be 2.5 r. The combined treatment produced benign and malignant tumors in all groups of animals, although the Swiss female mice were much more sensitive to it than were the C3H males.

Nearly all tumors observed in the irradiated animals appeared in areas that were shielded from the direct x-ray beam. The irradiated area usually was covered with a scar which was quite apparent, even in albino mice. Two hypotheses for this can be advanced: (1) With a weak carcinogen, a slight exposure of ionizing radiation or a chemical carcinogen could have a large effect upon the observed biologic response. (2) Intensive irradiation of skin (or other tissue) leads to systemic sensitivity to carcinogenic agents.

The authors point out that animal experimentation cannot be used as a direct measure of the hazard to human beings associated with an environmental agent. This is particularly true in the present series of experiments. The irradiation employed in these studies was not comparable to that of human environment in either quality or quantity.

Four photomicrographs; 3 photographs; 2 tables.

Further Observations on the Effect of X-Irradiation on the Glycogen Content and Histology of the Rabbit Retina. Sidney P. Kent. Radiation Res. **10:** 380–385, March 1959. (University of Alabama Medical Center, Birmingham, Ala.)

In 1957 (Radiation Res. **6:** 111, 1957. Abst. in Radiology **69:** 916, 1957), the author described some effects of high-intensity x-irradiation on the rabbit retina. The purpose of the present investigation was to determine (1) the effect of varying doses of irradiation on the histology and glycogen content of the retina and (2) whether these effects are indirect.

The heads of groups of New Zealand white male rabbits were exposed to 3,000 r, 4,000 r, 5,000 r, 6,000 r, 7,000 r, and 10,000 r of x-irradiation. In another group of rabbits the head received 6,000 r with one eye shielded by lead. Glycogen was found to accumulate in the outer nuclear layer of the retina in all animals except those in the 3,000 r group. This accumulation was associated with morphologic changes suggestive of cell death. Shielding one eye with lead completely protected that eye from such changes. It is thought that the accumulation of glycogen in the eye is probably effected by a mechanism different from that responsible for changes in liver glycogen after whole-body irradiation.

Four photomicrographs.

Protection of the Irradiated Ground Squirrel by Cysteine. Douglas E. Smith. Radiation Res. **10:** 335–338, March 1959. (Division of Biological and Medical Research, Argonne National Laboratory, Lemont, Ill.)

The possibility of cysteine protection against the lethal effects of ionizing irradiation was studied in the ground squirrel. In one group of animals cysteine hydrochloride (950 mg./kg. body weight) was given intravenously about ten minutes prior to a single total-body exposure to 1,000 r of x-rays. A control group of squirrels was anesthetized, sham-operated, and irradiated, but not treated with cysteine. At thirty days after exposure all the cysteine-treated but only 2 of the control animals were alive. In a similar experiment it was found that cysteine injected intraperitoneally was without such a protective effect.

Hibernation was induced in another group of 30 squirrels by transferring them to a cold room (5° C.) where they were deprived of food and water. One week after they had been in hibernation, the animals were irradiated. After twenty-two additional days in hibernation, they were removed to a room at 23° C. Immediately before they awoke from hibernation, 15 animals were injected intravenously with cysteine hydrochloride; the remaining 15 were sham-operated but not injected. No evidence of a significant protective action by cysteine was observed. An incidental finding was that within thirty to sixty minutes after irradiation at 5° C., half of the hibernating squirrels kept at 5° C. became fully awake and active. By the end of the next thirty-six hours these animals were in deep hibernation once again. During the ensuing twenty days in the cold all but 3 of the 30 animals awoke from hibernation two to four times. These periods of wakefulness lasted no longer than twenty-four hours and occurred apparently at random throughout the period in the cold. In a simultaneously observed group of 12 nonirradiated, hibernating ground squirrels there were no spontaneous awakenings.

The author concludes that intravenous injection of cysteine prior to irradiation significantly protects the nonhibernating ground squirrel from the lethal effect of x-rays. Such protection was not demonstrated when cysteine was administered to the hibernating ground squirrel after irradiation. The inability of the ground squirrel to stay in hibernation continuously after irradiation is considered further evidence that radiation-induced changes occur in this hibernating animal.

One graph.

Tissue Reactions to Autologous and Homologous Musculofascial Grafts. I. Effect of Exposure of Grafts in Vitro to X-Radiation Before Transplantation. Richard H. Andresen, Clarence W. Monroe, Dorothy Madden, Fay H. Squire, and George M. Hass. Arch. Path. **66:** 89–95, July 1958. (F. H. S., 1753 W. Congress St., Chicago 12, Ill.)

After resection from the donor and prior to implantation in the recipient, autologous and homologous musculofascial tissue from rabbits was irradiated *in*

vitro with x-rays. Microscopic study of the grafts, one to three weeks after implantation, led to the following observations: Irradiation with 100 to 250 r did not interfere with development of classical host-graft interactions. Irradiation with 500 r and 750 r reduced the intensity of host-autograft reactions and eliminated the capacity of homologous tissues to induce distinctive host-homograft reactions. Irradiation with 1,000 to 5,000 r reduced all grafts to the common state where the host-graft interactions were identical. These were characterized by vascularized stromal encapsulation and penetration of the graft by tissues of the host without much response by tissues of the graft. Irradiation with 10,000 to 90,000 r led to a common inert interaction between all grafts and the host, so that the grafts tended to persist unchanged, being encapsulated by fibrous tissue of the host without vascularized stromal penetration or other significant admixture of tissues of the host with those of the graft. These data indicate that advantage may be taken of the apparent levels of increasing inactivation of properties of grafts to assist in a study of factors responsible for desirable and undesirable interactions between tissues of the host and tissues of unmodified grafts.

Four figures; 1 table. AUTHORS' SUMMARY

Tensile Strength of Irradiated Freeze-Dried Arterial Grafts. T. Horne, A. V. Pollock, and K. S. Zinnemann. Brit. M. J. **1**: 830–831, March 28, 1959. (University of Leeds, Leeds, England)

Gamma radiation from a cobalt source was applied to the sterilization of 10 freeze-dried human aortic segments in a study of the effects of such irradiation on the segmental tensile strength.

Two equal lengths were taken from each aorta and freeze-dried separately by the single-stage method. One length was retained as a control and the other was irradiated. A dose of 2×10^6 rad of gamma radiation was given: at 20° C. to 5 specimens, and at −15° C. to 5. Irradiation caused weakening in every instance, more marked at 20° C. but still significant at −15° C. This reduction in tensile strength apparently reflects damage not detectable histologically.

As the authors' results with β-propiolactone-sterilized freeze-dried arteries show an actual increase in tensile strength, they continue to prefer that method of sterilization to irradiation.

Two tables.

Radiation and the Health Officer. Abel Wolman. Yale J. Biol. & Med. **31**: 231–246, February 1959. (Johns Hopkins University, Baltimore, Md.)

Prevention of disease and injury is the health officer's charge in radioactivity problems as in the more familiar domains of his past. Radiation hazards are real, exposure is increasing and adds to body stresses, and, once radiation damage occurs, therapy is nonexistent. The prevention of accidents requires the highest degree of supervision of all sources of radiation and continuing and perpetual alertness to the observance of evolving criteria and rules of operation and behavior.

While the prime advantages of radiation to medicine and industry cannot be overestimated, its use has resulted in voluntary and official agencies delineating the limits to which the individual may be exposed with minimal risk. In general, it is fair to say that all steps designed to minimize unnecessary irradiation of human populations will bring great benefits in human health.

A great deal of emphasis is now being placed upon the actual exposures from diagnostic radiology and the genetic consequences. Investigations of procedural methods have resulted in such modifications of current radiological practice as revisions, promulgated by the U. S. Public Health Service and a number of states, in tuberculosis x-ray case-finding practice, changes in the employment of roentgenology during pregnancy, and significant control of the indiscriminate use of the fluoroscope. In the more advanced hospitals, detailed supervision of both the diagnostic and the therapeutic use of radioisotopes has come into force. Somewhat more elaborate administrative control units have appeared throughout the country with astonishingly detailed regulatory programs already operative.

Uses of powerful x-ray sets in industry are rapidly increasing. Employment of reactors in submarines, surface ships, air craft, and space rocket propulsion poses unexplored and at the moment unsolved national and international issues. Gaseous, liquid, and solid wastes should be kept to a minimum, should always be contained, and should be kept separate and distinct for identification and monitoring. Good housekeeping is the key to safety.

Transportation of radioactive substances has been given detailed attention by the Atomic Energy Commission with particular reference to type of container, freight, safety hazard, costs, transportation mode and vehicle, and route of shipment.

Eight states have adopted broad, comprehensive radiation control regulations and 13 others require registration of hazardous radiation sources. Many states are concerned with radioactive wastes and it is probable that soon every state will adopt some procedure for health and labor departments to assume these responsibilities. And for the first time in history the discharge of radioactive wastes into the seas found a place on the agenda of the International Conference on the Seas at the 1958 Geneva sessions.

In the control and regulation of radiation sources, the criteria set forth by the National Committee on Radiation Protection are accepted by most individuals and public health agencies. The mere existence of these permissible levels, however, is not a substitute for continuing administrative judgment. Each permissible level suggested implies a certain degree of risk. The health official in every instance calling for decision is confronted with the necessity of balancing risk against values to society.

Pathological Reaction in Acute Radiation Sickness. I. R. Petrov and V. K. Kulogia. Med. Radiol. (Moscow) **2**: 3–12, March-April 1957. (Academy of Medical Sciences USSR)

Dr. Marshall Brucer has prepared for American readers a translation of a Russian contribution to the subject of radiation sickness, which is of interest because of its different point of view as compared to American studies. Introducing the translation, Dr. Brucer writes:

"The scientists in the USSR have an entirely different approach to radiation sickness than we have in this country. I have attempted to find among many translations a Russian statement that summarizes the USSR scientists' position fairly completely. The document by Petrov and Kulogia is the best statement that

I have found so far. This document was translated by the National Institutes of Health, but this is a layman's translation. I have tried to rewrite it into American medical English but still keep the ideas of the original authors. This is an attempt to interpret a Russian document; however, it should be remembered that any errors in interpretation are mine and not those of the authors. The ideas (as far as I have been able to interpret them) are the authors' and not mine."

The translation cannot be reprinted here in full, but excerpts to give some idea of the views expressed are reproduced:

"Most diseases can be interpreted as a breakdown in the function of a particular physiological system. Radiation sickness has its great importance in that it is the simultaneous breakdown in function of many systems. . . .

"*Oxygen Deficiency:* The radiation of animals under conditions of oxygen deficiency lowers the mortality rate by 30 to 50 per cent when a lethal dose is given (Dowdy, Brues (?), Bennet, and Chastin). The introduction of cyanamides (?) before irradiation decreases the mortality rate of animals (Bacq and Herwe). Blood loss immediately before radiation exposure causes a less severe course of radiation sickness (H. Yo. Chaykevskaya, O. S. Sergel', S. L. Petroayna, and G. N. Yolgat'yevskaya). Blood letting (10 to 20 per cent of the blood volume) immediately after irradiation increased the number of animals that survived (V. N. Pravetskiy). In contrast, blood letting (20 to 40 per cent of the blood volume) fifteen to thirty minutes and twelve hours after irradiation with a dosage of 500 r reduced life span and often had a lethal effect. There is no doubt that breathing rarefied atmosphere has an unfavorable influence upon the course of radiation sickness (R. N. Mihbayliv); but on the other hand animals that have first been sensitized to oxygen deficiency better withstand the influence of ionizing radiation (I. F. Bartashava). Thus, this one factor of oxygen hunger, depending upon degree and time of action, can either aggravate or ease the course of radiation sickness.

"*Localization of Effect:* The most severe changes occur when the organism receives total-body irradiation. Irradiation of the rear extremities causes fewer changes than irradiation of the stomach area. Shielding of the stomach during irradiation of the stomach area causes less change by radiation.

"According to the data of E. Ya. Yamasa, there is a profound depression of the biocurrents in the cortex of the brain eighteen to twenty-four hours after irradiation of either the head or the total body. On the second or third day the restoration of the bioelectrical activity of the cortex is noted. The conditioned reflexes are restored in three to four days, when only the head receives radiation, and by the end of the first week when the total body is irradiated. Radiation of the torso causes less critical change than radiation of the total body. These changes disappear on the second day.

"*Four Periods of Development in Radiation Sickness:* 1. The *first period* (initial reaction) lasts no more than a day. There is a breakdown in the function of the central nervous system, the cardiovascular system, breathing, blood, thermoregulation, and a breakdown in the function of the digestive tract. The breakdown in the function of the central nervous system is noted immediately after irradiation.

"2. The *second period* (latent period) lasts for four to seven days. There are no clearly expressed symptoms of the disease, yet careful observation convinces one that there is a further development during this period. The breakdown of higher nervous activity and changes in peripheral blood and bone marrow which were noted on the first day progress and reveal themselves during the latent period.

"3. The transition to the *third period* (clinical symptoms) is gradual. Hemorrhages, increased body temperature, angina, sores, swelling, etc., reveal themselves. Severe forms of radiation sickness end in death between the twelfth and eighteenth day after irradiation.

"4. The *fourth period* (restoration), a gradual restoration of the functions and structures, is observed twenty-five to thirty days after irradiation. This period sometimes lasts for a long time and does not end in complete recuperation, since remote consequences such as premature aging frequently remain."

The Russian authors appear to be stressing the effects of irradiation on the nervous system with humoral factors playing a minor role. The hematologic syndrome is treated more as a result of changes that have already occurred than as the cause of changes.

"*Conditioned Reflexes:* P. D. Gerisentev points out that for forty to sixty minutes after total-body irradiation a phase of increased stimulation of the brain cortex is expressed in an increase in conditioned reflexes. Internal inhibition is lessened, differentiation is disturbed, and there is a weakening of extinctive inhibition. . . .

"Myographic and electrophysiological research by N. N. Livanov and associates shows that several minutes after total irradiation in large doses there is an intensification of the impulses entering the cortex of the brain. Simultaneously there is increased electrical activity in subcortical functions. The spinal-fluid centers show decreased conductivity. One to three hours after irradiation, both under the influence of the direct action of radiation on nerve tissue and under the influence of the pathological impulses from the periphery, there are breakdowns in the conditioned-reflex activity of the vegetative functions, particularly in the cortex of the large hemispheres.

"*Blood Changes:* In the initial period there is a leukocytosis with an increased number of neutrophils and a sharp fall in the number of lymphocytes followed by a clearly expressed leukopenia. G. F. Gargonsyev finds a phase of unstable equilibrium in doses up to 480 r characterized by alternate increase and decrease in the number of lymphocytes, which is then replaced by leukopenia. With large doses, leukopenia develops by the seventh to fourteenth day to 100 WBC. There is a simultaneous thrombocytopenia.

"Erythrocytes decrease and hemoglobinemia sometimes is observed during the first day following irradiation. There is slow development of anemia during the second week, when considerable hemorrhage and severe changes in bone marrow occur.

"1. V. El'iaskaya's research demonstrates considerable suppression of bone marrow soon after exposure. In some animals there is a total depletion of bone marrow by the fourteenth day. . . .

"The degree of morphological change in blood is different in different species of animals and depends upon dosage and species. . . .

"*Interaction of the Blood and Nervous Systems:* The

reaction of the blood after irradiation depends greatly upon the state of the nervous system. Pep and Seyas note that a blood reaction is detected when the marrow is exposed to dosages of 5 r; a larger dose is required when only the chest and stomach are exposed. If the brain is shaken, even a dosage of 1 r can cause reactive changes in the blood. Lawrence and Valentine show that with transfusion of animals unexposed to radiation but receiving blood from an animal that has been exposed to radiation there is no blood reaction, a fact that attests to the minor role played by a postulated humoral factor.

"The hemorrhagic diathesis is one of the reasons for the development of anemia. It might be the reason for the death of the animal. It is known that penetrating radiation causes a considerable thrombocytopenia and prothrombopenia on the one hand, and increases the penetrability of the vascular walls and the friability of capillaries on the other hand. . . .

"*The Genesis of Hemorrhage:* The genesis of hemorrhage has been explained primarily by increased vascular penetrability and decreased blood coagulability. The views have been contradictory. In recent times T. K. Dzharak'yan attaches importance to blood circulation and other factors.

"Hemorrhages are explained by: (*a*) increased vascular penetrability as a consequence of neurodystrophic changes; (*b*) decreased coagulability; (*c*) breakdown in blood circulation, and the development of capillary stasis. Only a calculation of the changes in the nervous control of the trophicity of the vascular wall, blood circulation, and blood coagulation will make it possible, in our opinion, to understand the mechanism of the development of severe hemorrhages and to apply efficient measures of prophylaxis and therapy.

"*The Digestive System:* A. Fuganburg, etc., points out the suppression of the secretion of the stomach glands, decrease in the secretion of the pancreas, and decrease in the peristalsis of the intestines. This creates conditions for the limitation of the digestion of food and for the development of gastrointestinal intoxication. There is an intensified multiplication of intestinal flora linked with a breakdown of the function of the intestinal barrier and a decrease in the immune properties of the organism. In radiation sickness severe atrophic processes occur in the mucous membrane of the intestine. The intestine becomes thin, and this is one of the causes of intestinal hemorrhage."

The authors go on to discuss briefly the acute radiation syndrome, which they regard as primarily a chemical effect.

"Radiation sickness is characterized by the formation of vicious circles. A large role is played by the breakdown of nervous activity. Anemia, infection, and intoxication aggravate the disorder of nervous activity. The breakdown in blood formation is aggravated by the hemorrhagic syndrome. The organism's adaptor reactions prove to be reduced.

"*Therapy:* The therapy of radiation sickness must be directed at eliminating the principal multiple disorders. It cannot be stereotyped since the factors that play the principal role at the different stages of the disease are not identical."

A bibliography of 39 references, mostly to the Russian literature, follows in the original paper. No attempt is made here to include these references, and it should be recognized that spellings of the Russian names in the body of the document may frequently be inaccurate.